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VORK MANUALS. No. I.

THE

PREPARATION AND USE

OF

CEMENTS AND GLUE.

By JOHN PHIN,

EDITOR OF THE "YOUNG SCIENTIST," AND THE
"AMERICAN JOURNAL OF MICROSCOPY."

NEW YORK:
THE INDUSTRIAL PUBLICATION COMPANY.
1881.

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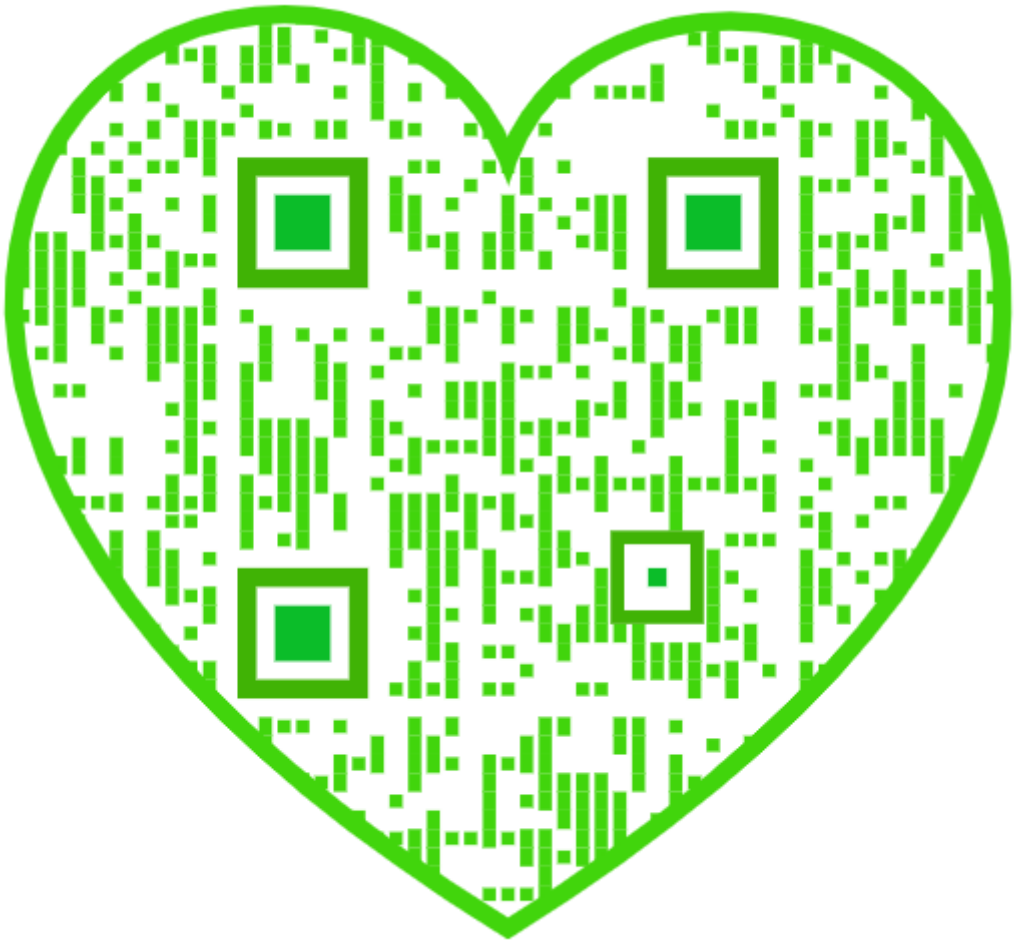

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PREFACE.

Cements form such a ready means of uniting the parts of new articles, as well as of those which have been broken, that there are few persons to whom a knowledge of the best methods of preparing and applying them would not be useful. At present, such information is to be found only in a scattered and fragmentary form in Cyclopædias, Handbooks, and Journals, and no thorough and systematic statement of the principles which must be followed in order to secure success, can be anywhere found. Indeed, so far as we are aware, the only general articles that have been published on glues and cements are those which have been written by the author of the present brochure. One of these articles entitled: "Cements and How to Use Them," which appeared in the *Technologist*, Vol. I, 1870, has formed the basis of most of the recent "Introductions," to the articles on cements, in the popular Books and Cyclopædias of Recipes—Spon, Dick, and others, having appropriated it without acknowledgment. The history of this article was somewhat amusing. Shortly after its appearance in the *Technologist*, it was copied into the *English Mechanic* and architectural journals, generally without acknowledgment. As soon as these papers reached this country, it was eagerly picked up by our American journals and copied by them, but *always* credited to the foreign periodicals.

The most amusing circumstance, however, was the fact that a writer for the mechanical journals, finding it in an obscure English paper, and thinking it a good thing, made a few slight changes in it, and sent it to us as an original production. We sent him, without any comment, a copy of the number containing the original article, and that was the last we ever heard from our correspondent.

In preparing this little book the utmost care has been taken to secure accuracy. When we consider the number of utterly worthless recipes which have been published with the sanction of names which stand high in the mechanical world, it is no wonder that even the best collections have admitted useless formulæ to their pages. We believe that most of the formulæ here given will do all that is claimed for them, and, wherever we have had any doubt upon this point, we have intimated it. The reliability of many of the recipes we know from personal experience.

During the past dozen years the author has contributed to the industrial journals several articles upon glue and cements, and where passages from these articles have been incorporated in this work, it has not been thought necessary to make special acknowledgment.

It would have been easy to have extended this treatise to several times the present size, but we believe that it now contains all that is generally useful.

JOHN PHIN.

New York, May, 1881.

CEMENTS AND GLUE.

The term "cement" is applied to two very different articles used in the arts. Sometimes it means those fine mortars which are used for uniting stones or bricks in building, and for coating the surfaces of walls, floors, etc.; at other times it means those pastes, glues and other adhesive substances which are employed for the purpose of uniting different pieces of material together, and it is in this sense that we employ it in the following pages.

The number of adhesive cements which have been discovered and invented, is very large, so that in order to present them in convenient form, they should be properly classified and arranged. In attempting to do this, however, we meet with unexpected and serious difficulties, from the fact that there are so many systems according to which the various cements may be arranged, and all apparently eligible. Each of these systems has its own advantages and defects, and, unfortunately, it is impossible to so combine them as to avoid these objections. Of the several ways in which cements might be classified, the following are examples:

1. According to their composition. Under this arrangement animal glues would be placed in one class, vegetable gums in another, resins in another and so on.

2. According to the purpose to which they are to be applied; those for uniting wood in one class, those for joining leather in another, and so on.

3. According to their behavior in drying or hardening, as is more fully explained hereafter.

None of these plans seem to us to meet the requirements of the case, and therefore we shall adopt a less scientific, but, as we think, a more practically useful system, and arrange the different cements in alphabetical order, giving such indices and cross references as will enable any one to turn at once to the formula which may be needed.

GENERAL RULES FOR THE USE OF CEMENTS.

Some years ago the writer called attention* to the fact that quite as much depends upon the manner in which a cement is used as upon the cement itself. The best cement that ever was compounded would prove entirely worthless if improperly applied. Hence we constantly see failures occurring in the use of cements, notwithstanding the fact that we have cements which answer every reasonable demand, when they are properly prepared and properly used. Good common glue will unite two pieces of wood so firmly that the fibres will part from each other rather than from the cementing material; two pieces of glass can be so joined that they will part anywhere rather than on the line of union; glass can be united to metal, metal to metal, stone to stone, and all so strongly that the joint will certainly not be the weakest part of the resulting mass. But in order to be successful in the use of any cement, we must understand its character and properties, and conform to them our methods of application.

Every cement may be assigned to one of four classes, according as it (1), Dries by evaporation; (2), Congeals by cooling; (3), Hardens by oxidation, or (4), "Sets" by chemical changes. To the first class belong pastes, mucilages, alcoholic and other solutions of gums and resins, and, to a certain extent, glue. To the second belong such cements as sealing-wax, turner's cement, shellac, etc. The third class includes gold size, drying oil, white and red lead, etc., and the fourth class covers plaster-of-Paris, the so-called iron cement, and others of that kind.

* Technologist, Vol. I., (1870), page 188.

If the best results would be attained the following rules must be rigorously adhered to:

1. The cement must be brought into intimate contact with the surface to be united. Thus, when glue is employed, the surface should be made so warm that the melted glue will not be chilled before it has time to effect a thorough adhesion; a drop of melted glue allowed to simply fall on a surface of dry, cold wood and solidify there, will often fail to adhere at all, while if the same drop had been rubbed in, it would have attached itself to it with wonderful power of adhesion. The same is more eminently true in regard to cements that are used in a fused state, such as mixtures of resin, shellac and similar materials. These matters will not adhere to any substance unless the latter has been heated to nearly or quite the fusing point of the cement used. This fact was quite familiar to those who used sealing-wax in the old days of seals and twenty-cent postage. When the seal was used rapidly, so as to become heated, the sealing-wax stuck to it with a firmness that was annoying, so much so that the impression was in general destroyed, from the simple fact that the sealing-wax would rather part in its own substance than at the point of adhesion to the stamp. Sealing-wax, or ordinary electrical cement, is a very good agent for uniting metal to glass or stone, provided the masses to be united are made so hot as to fuse the cement, but if the cement be applied to them while they are cold, it will not stick at all. This fact is well known to the itinerant venders of cement for uniting earthenware. By heating two pieces of delf so that they will fuse shellac, they are able to smear them with a little of this gum, and join them so that they will break at any other part rather than along the line of union. But although people constantly see the operation performed, and buy liberally of the cement, it will be found that in nine cases out of ten the cement proves worthless in the hands of the purchasers, simply because they do not know how to use it. They are afraid to heat a delicate glass or porcelain vessel to a sufficient degree, and they are apt to use too much of the material, and the result is a failure.

The great obstacles to the absolute contact of any two surfaces, are air and dirt. The former is universally present, the latter, is due to accident or carelessness. All surfaces are covered with a thin adhering layer of air, which is difficult to remove, and which, although it may at first sight seem improbable, bears to the outer surface of most bodies a relation different from that maintained by the air a few lines away, and until this layer or film of air has been removed, it prevents the absolute contact of any other substance. The reality of the existence of this adhering layer of air is well known to all who are familiar with electrotype manipulation, and it is also seen in the case of highly polished metals, which may be immersed in water without becoming wet. Thus the surface of a needle retains this film of air so strongly that it will float on the surface of water rather than give it up.

Unless this adhering layer of air is displaced, it will be impossible for any cement to adhere to the surface to which it is applied, simply because it can not come into contact with it.

The most efficient agents in displacing this air are heat and pressure. Metals warmed to a point a little above 200° Fahr., become instantly and completely wet when immersed in water. Hence for cements that are used in a fused condition, heat is the most efficient means of bringing them in contact with the surfaces to which they are to be applied.

When it is intended to unite two pieces of earthenware or glass together, or a piece of glass or other substance to metal, by means of a cement that is to be used in a fused state, the surfaces that are to be united should always be made so hot that the cement will become perfectly liquid when brought in contact with them.

In the case of glue, the adhesion is best attained by pressure and friction, combined with moderate warmth. In large establishments, where good glue joints are an important item, a special room, carefully warmed, is set aside for this operation.

2. A very important point is that as little cement as possible should be used. When the united surfaces are separated by a large mass of cement, we have to depend upon the strength of

the cement itself, and not upon its adhesion to the surfaces which it is used to join; and, in general, cements are comparatively brittle. At first sight one would suppose that the more cement there is used, the stronger will be the joint, and this is an error into which most inexperienced persons fall. Two pieces of earthenware, joined together by a layer of shellac as thin as possible, will adhere together and will be as strong at the junction as at any other part, while the same pieces united by means of a layer of the same cement an eighth of an inch thick, would fall apart on receiving the slightest jar. The rule which directs us to use as little cement as possible, admits of no exceptions, and as a general thing the only way to obtain thin layers of cements that are to be used in a fused state, is to heat thoroughly the pieces that are to be united, press them forcibly together, and keep them under pressure by means of weights, screws, or cords until the cement has hardened.

3. The third point to which we shall call attention is the necessity for cleanliness, both in the preparation of the cements and in the application of them. It may be safely laid down as a positive rule that every extraneous substance that is mixed with the material of a cement is an injury to it. Glue prepared in a greasy pot cannot be expected to make a strong joint, and the presence of dust and dirt tends to weaken *all* cements. So, too, in the application of cements. If we attempt to glue together two surfaces of wood that are covered with dirt, the substances that are to be united are not wood to wood, but dirt to dirt, and the joint, instead of possessing the strength of wood, united by means of good glue, will have simply the strength of dirt. Moreover, we must remember that the different cements do not adhere with equal force to substances of different kinds. Thus, glue adheres powerfully to wood and paper, but not at all to metal or glass. Shellac, if properly applied, adheres readily to earthenware, glass and metal, but not to some other substances. If, then, we apply glue to a greasy surface it will not stick. Hence the necessity for great cleanliness. All surfaces should be kept as clean as possible, or if they should get accidentally soiled, they should be carefully cleaned.

The mere rubbing of two wooden surfaces with a dirty hand will weaken the subsequent glue joint by at least ten per cent.

The most common case in which this rule is violated by the inexperienced is in mending articles which have been formerly glued and have been again broken at the old place. Such articles when first mended, frequently last for a long time, but when a second attempt is made to glue the pieces together, the joint seems almost to fall to pieces of itself. Here we are attempting to glue together, not two pieces of wood, but two pieces of old glue, and the result is failure. Soak off all the old glue (do not cut or scrape it, or the pieces will no longer fit accurately together) wash the surfaces with a sponge dipped in boiling water, and when they are dry and warm, glue them together in the usual manner, and you will be surprised at the strength of the joint.

4. See that the opposing surfaces make a close, neat joint, before you attempt to cement them. Two pieces of wood that are to be glued together should be planed up so true that they are in contact at every point, and where an article has been broken, the surfaces to be joined should be preserved from being broken or battered. This is particularly the case when articles of glass or earthenware are accidentally broken, and it is not convenient to mend them on the instant. They should be carefully wrapped up in separate pieces of paper, and laid away where they will not be soiled, and where the edges will not be chipped. In such cases the joint will be greatly disfigured, and considerably weakened if the edges are chipped and broken by careless handling, or by being needlessly and frequently fitted together. Keep the pieces from contact with each other and with foreign substances until you are ready to join them, and the joint will then be not only strong but almost invisible.

5. Plenty of time should be allowed for the cement to dry or harden, and this is particularly the case with *oil* cements, such as copal varnish, boiled oil, white lead, etc. These cements are said to *dry*, but they do not dry by evaporation. Instead of losing anything, they actually gain in weight by absorbing

oxygen from the air, and this process of oxidation is a very slow one except as regards the very thin layer that is in immediate contact with the air. Thus when two surfaces, each half an inch across, are joined by means of a layer of white lead placed between them, six months may elapse before the cement in the middle of the joint has become hard. In such cases a few days or weeks are of no account; at the end of a month the joint will be weak and easily separated, while at the end of two or three years it may be so firm that the material will part anywhere else than at the joint. Hence, where the article is to be used immediately, the only safe cements are those which are liquified by heat and which become hard when cold. A joint made with marine glue is firm an hour after it has been made. Next, in rapidity of hardening, to cements that are liquified by heat, are those which consist of substances dissolved in water or alcohol. A glue joint sets firmly in twenty-four hours; a joint made with shellac varnish becomes dry in two or three days. Oil cements, (boiled oil, white lead, red lead, etc.), take months.

6 Where neatness as well as strength, is an object, it will often be advisable to use a cement of a color as nearly like that of the materials to be united as possible. Thus a white porcelain cup, mended with black cement, would show some very ugly lines. If, however, a white cement be used, the lines of fracture will be invisible. The same rule applies to other articles, and it is always easy to color a cement to any desired tint.

The following recipes and formulæ have been selected from the many thousands that have been published as being thoroughly trustworthy and efficient. We give one or two popular recipes in which, however, as we state, we have no great faith. Some we have marked doubtful; others we give on the general authority—"it is said." For ease of reference we have numbered the formulæ consecutively from the beginning to the end of the volume.

FORMULÆ FOR CEMENTS.

Acacia Gum. *See Gum.*

Alabaster Cement.

Cements for uniting pieces of alabaster, marble, Derbyshire spar, and other kinds of white stone, are in frequent demand. The following recipes give satisfactory results. Those containing resin must be applied hot, and the pieces to be joined must also be heated up to the melting point of resin.

1. Plaster-of-Paris made into a cream with water. This cement sets in a few minutes, but it does not become perfectly hard for several days, or until it has become thoroughly dry.
2. Yellow resin, 2 parts; melt and stir in 1 part of plaster-of-Paris, which has been thoroughly dried and heated.
3. Yellow resin, beeswax and plaster-of-Paris, equal parts.
4. Resin, 8 parts; wax, 1 part; melt and stir in 4 parts of plaster-of-Paris.

Amber Cement.

5. Two surfaces of amber may be united by smearing them with boiled linseed oil, pressing them strongly together, and heating them over a clear charcoal fire. To keep the parts in firm contact, it may be well to tie them with the soft iron wire known as binding wire.

Architectural Cement.

Architectural cement is a kind of papier-maché, and is used for making entire models, busts, ornaments, etc., rather than for uniting the parts of any article. It is very light and takes a good polish, but is easily affected by moisture.

6. Reduce paper to a smooth pulp by boiling it in water and work it over. Squeeze this paste dry, and add an equal bulk of whiting. Then mix the whole into a paste of the required consistence with good size or solution of glue.
7. Same as number 6, but with plaster-of-Paris instead of whiting.

Aquarium Cement.

This term has been applied to various water-proof cements which have been used for joining the sides, ends, etc., of tanks for holding water for various purposes. The following are some of the best.

8. Take of finely powdered litharge, fine, white, dry sand, and plaster-of-Paris, each 3 parts, by measure; finely pulverized resin, 1 part. Mix thoroughly and make into a paste with boiled linseed oil to which dryer has been added. Beat the mixture well, and let it stand four or five hours before using it. After it has stood for 15 hours, however, it loses its strength. When well made, of good materials, this cement will unite glass and iron so firmly that the glass will often split in its own substance, rather than part from the cement. We have united five plates of glass with this cement alone, and without any frame, so as to form a durable tank holding 5 gallons of water. Glass cemented into its frame with this cement is good for either salt or fresh water. It has been used at the Zoological Gardens, London, with great success. It might be useful for stopping leaks in roofs and other situations.

9. *Gutta-Percha Cement.*—This highly recommended cement is made by melting together, in an iron pan, 2 parts common pitch and 1 part gutta-percha, and stirring them well together until thoroughly incorporated, and then pouring the liquid into cold water. When cold it is black, solid, and elastic; but it softens with heat, and may be used as a soft paste, or in the liquid state as is most suitable. It does not harden and crack, and answers an excellent purpose in cementing metal, glass, porcelain, ivory, etc. It may be used instead of putty for glazing windows.

10. Red lead, 3 parts; litharge, 1 part; made into a paste or putty with raw linseed oil.

11. A cement which gradually hardens to a strong consistence may be made by mixing 20 parts of clean river sand, 2 of litharge, and 1 of quick lime, into a thin putty with linseed oil. When this cement is applied to mend broken pieces of stone, as steps of stairs, it acquires, after some time, a stony hardness, and unites the parts with great firmness.

12. It is said that a cement of great adhesiveness may be made by mixing six parts of powdered graphite with three parts of slacked lime, eight parts of sulphate of baryta, and seven parts of linseed-oil varnish. The mixture must be stirred to uniform consistency.

Arabic Gum. (*See Gum.*)

Armenian Cement—Diamond Cement.

13. The jewellers of Turkey, who are mostly Armenians, have a singular method of ornamenting watch cases, etc., with diamonds and other precious stones, by simply gluing or cementing them on. The stone is set in gold or silver, and the lower part of the metal made flat, or to correspond with that part to which it is to be fixed. It is then warmed gently and the glue applied, which is so very strong that the parts thus cemented never separate. For this glue, which will firmly unite bits of glass and even polished steel, and which may, of course, be applied to a vast variety of useful purposes, a large number of formulæ have been published. The following is the original recipe, which we have traced through various chemical works back to the end of the last century: Dissolve five or six bits of gum mastic, each the size of a large pea, in as much alcohol as will suffice to render them liquid; in another vessel dissolve as much isinglass, previously a little softened in water, (though none of the water must be used), in good brandy or rum, as will make a two-ounce phial of very strong glue, adding two small bits of gum galbanum, or ammoniacum, which must be rubbed or ground until they are dissolved. Then mix the whole with a sufficient heat, keep the glue in a phial closely stoppered, and when it is to be used, set the phial in boiling water. To avoid the cracking of the phial by exposure to such sudden heat, use a thin, green, glass phial, and hold it in the steam for a few seconds before immersing it in the hot water.

The following recipes also give very excellent results:

14. *Dr. Ure's Formula.*—Isinglass. 1 oz.; distilled water, 6 oz.; boil to 3 oz., and add rectified spirit, 1½ oz.; boil for a minute or two, strain and add while hot, first, a milky emulsion of ammoniac, ½ oz., and then tincture of mastic, 5 dr.

15. *Keller's Formula.*—Soak ½ oz. of isinglass in 4 oz. water, for 24 hours; evaporate in a water bath to 2 oz., add 2 oz. rectified spirit (alcohol 85 per cent.), and strain through linen. Mix this solution while warm with a solution of best gum mastic in 2 oz. alcohol; add 1 dr. powdered gum ammoniac, and triturate together until perfectly incorporated, avoiding loss of the alcohol by evaporation as much as possible.

16. Isinglass dissolved in alcohol (by first soaking in water) 3 oz.; bottoms of mastic varnish (thick but clear), 1½ oz.; mix well.

Badigeon.

17. A cement used for filling up holes and covering defects in mechanical work. The most commonly used is putty, colored to suit. Statuaries use a mixture of plaster and freestone for this purpose; carpenters, a mixture of saw dust and glue; coopers, a mixture of tallow and chalk. The same name is given to a stone-colored mixture used for the fronts of houses, and of which the published composition is wood-dust and lime, slaked together, stone-powder, and a little umber or sienna mixed up with alum water to the consistence of cement. The real composition is probably some good hydraulic cement colored to suit. See also *Mahogany Cement.*

Botany Bay Cement.

18. This is composed of equal parts of yellow gum (Botany Bay gum), and brick dust melted together. Botany Bay gum is a gum resin produced by a plant which grows in New Holland.

Bottle Cement.

19. In the better class of preparations, good sealing wax is used when the object is merely to ornament the cork. Where it is desired to close the pores of cork hermetically, a softer and more tenacious cement should be used, *Chemical cement* (40) or *Glycerine cement* (77) are good. The following are well tried recipes for bottle cement or bottle wax.

20. Shellac, 2 lbs.; resin, 4 lbs; Venice turpentine, 1½ lbs.; red lead, 1½ lbs. Fuse the shellac and resin cautiously in a copper pan over the fire; when melted add the turpentine, and lastly the red lead, which should be dry and warm. Pour into moulds, or make it into sticks by rolling on a marble slab. Care must be taken to have the red lead equally diffused through the melted mass by constant stirring, as owing to its great specific gravity it is apt to sink to the bottom.

21. Resin and beeswax, equal parts; melt them together and add sufficient Venetian red to give a good color, and enough neatsfoot oil to prevent its being brittle when cold.

22. Sealing wax, 1 lb; resin, 1 lb; beeswax, 8 ounces; melt together. Bottles may be sealed by dipping the corks in this melted mixture. If it froths, add a very small piece of tallow and stir.

23. Resin, 15 parts; tallow, 4; beeswax, 2; melt and color with red ochre or ivory black.

24. Black pitch, 6 lbs; ivory black and whiting, each 1 lb. Melt the pitch and add the other ingredients hot and dry.

25. *Maissiat's Cement.*—India-rubber is melted either with or without about 15 per cent of either beeswax or tallow; quicklime in fine powder is gradually added, and the heat continued until change of odor shows that combination has taken place, and until a proper consistence is obtained. Used as a waterproof and air tight covering for corks, bungs, etc.

(26). Copal varnish made thick with zinc white, red lead, ivory black or any other color and applied like a paint.

Brimstone Cement.

27. Roll sulphur is frequently used alone as a cement for fastening iron bars in holes drilled in stone. The addition of brick dust, sand or resin, lessens its liability to crack. When the yellow color of brimstone is an objection, a little plumbago may be mixed with it.

British Gum. *See Dextrine.*

Buckland's Cement.

28. White sugar, 1 oz.; starch, 3 oz.; gum arabic, 4 oz. These should all be separately reduced to a very fine powder, and then rubbed well together in a dry mortar; then little by little add cold water until the mass is of the thickness of melted glue; put in a wide mouthed bottle and cork closely. The dry powder itself, thoroughly ground and mixed, may be kept for any length of time in a wide-mouthed bottle, and when wanted a little may be mixed with water with a stiff brush. It answers ordinarily for all the purposes for which mucilage is used, and as a cement for labels it is specially good, as it does not become brittle and crack off.

Canada Balsam.

29. This material forms a very useful cement for many purposes. It is the only cement employed by opticians for uniting the lenses of achromatic objectives. For this purpose it must be pure and colorless. It is easily bleached by exposure to sunlight. If too thick, it may be thinned with benzole.

In cementing the two parts of an achromatic lens together, the surfaces should be thoroughly cleaned, and the glasses having been previously warmed, should be laid on some surface which will not scratch them. By means of a rod of glass or metal, place a drop of balsam on the centre of one lens, and then gently lower the other down upon it. Now apply a slight pressure, and the dark disc in the centre, indicative of optical contact, will rapidly increase in size, until at last the balsam reaches the margin and begins to ooze out at the edges, if the balsam be in excess, as it ought to be. By means of a

piece of soft string, if the lenses are large, or a spring clip, if they be small, the lenses should be held firmly together and exposed to a gentle heat in an oven that is cooling, or before a fire, until the balsam at the edges has become hard and dry. The string or clip may then be removed, and all external traces of balsam removed, first by scraping, and afterwards with a little benzole or ether. The above directions, modified to suit circumstances, apply to the cementing of glasses for transparencies or opal pictures; also to the varnishing of magic lantern slides, and the protection of any transparent surfaces from the air.

30. Canada balsam forms a very efficient and easily applied cement for the construction of small tanks used by microscopists for keeping minute plants and animals alive in water.

Caoutchouc. *See India Rubber.*

Cap Cements.

These cements are so called because they are used for fixing brass caps, stop cocks, etc., on glass apparatus. There are two kinds of cement in use for this purpose; one consists of resin and other matters, and is fusible by heat, so that it is easily applied, takes very little time to harden, and if the glass should get broken, or if the brass work requires to be changed, it is very easy to separate the parts by the action of heat. When properly applied, this cement is perfectly air tight, and is very strong. The only objection to it is that it is easily softened by heat, and, therefore, it cannot be used for apparatus to which heat is to be applied. For air pumps and other pneumatic apparatus, and similar purposes, it answers perfectly. The other cement consists of white or red lead ground in boiled oil, and applied either to the naked surfaces, or by spreading it on a cloth, which is then placed between the surfaces to be united. The advantages of this kind of cement is that it will stand any heat below 300° Fahr., and that it is steam and air tight. The objections are that it takes a long time to dry, and that when it has been used to unite pieces of apparatus, it is almost impossible to separate the parts without breaking the glass. This may occasionally be effected, however, either by heating the joint very strongly or by soaking in solution of caustic potash or soda.

31. *Faraday's Cap Cement.—Electrical Cement.*—Resin, 5 oz.; beeswax, 1 oz.; red ochre or Venetian red in powder, 1 oz. Dry the earth thoroughly on a stove at a temperature above 212°. Melt the wax and resin together and stir in the powder by degrees. Stir until cold, lest the earthy matter settle to the bottom. Used for fastening brass work to glass tubes, flasks, etc.

Faraday's directions for fastening caps to the ends of tubes or retorts are as follows: "One is to be selected of such size as to admit the tube and allow a space for cement about the thickness of a card or a little more, but the cap should never be so small as itself to gripe the glass, or any larger than is necessary to allow room for cement to surround the glass. The cement should be heated to fluidity on the sand bath, but not to a greater degree; the cap should be warmed over a candle or lamp until it is hot enough to melt cement, and then that part of its interior which is intended to come against the glass, viz; the sides of the cylinder, should be covered with the hot cement, applied by a piece of stick. The cap being then laid on its side by the sand-bath to keep it from cooling, the end of the tube or retort is next to be warmed, and a coat of cement applied on the exterior, over every part which is to come into juxtaposition with the cap, but the other parts are not to be unnecessarily soiled; so much cement is to be left adhering to the glass, that with what there is in the cap, there may be an excess above the quantity that can be retained between the glass and metal when the two are fitted together. When the cap, glass and cement are all so warm that the latter is fluid or very soft, the cap is to be placed upon the tube, thrust into its right position, receiving a little rotary motion, at the same time to distribute the cement equally over all parts, and is afterwards to be set aside to cool. When this is well performed, the retort neck or tube should pass along until it is stopped by the inside of the shoulder; no cement should soil its interior or project within the cap, but it should fill every part between the glass and the cap to make a firm, tight junction, and project in a ring from the edge of the cap over the exterior of the glass. The superabundance is easily removed by a knife, and the annular surface left made smooth and tight by a hot wire passed rapidly over it. If a piece of cement, pushed on by the edge of the glass, project in the inside of the cap, it should when nearly cold, be cut off by a knife and removed, so that no loose fragment may remain in the retort or tube."

32. *Varley's Cement.*—Take whiting, dry it thoroughly at a

red heat, and reduce it to very fine powder. Melt together 16 parts of black resin, and 1 part of beeswax, and stir into the melted mass 16 parts of the dry and warm whiting, which should not be so hot as to effect the resin, however.

33. *Singer's Electrical Cement.*—Take of resin, 20 parts beeswax, 4 parts; red ochre, 4 parts; plaster-of-Paris, 1 part. Dry the powders thoroughly, and add them while warm to the melted resin and wax.

34. A cheaper cement, for lining voltaic troughs, is made of 6 lbs. resin; 1 lb. red ochre; ½ lb. plaster-of-Paris, and ¼ lb. linseed oil. The ochre and plaster should be thoroughly dried and heated, and added to the other ingredients in their melted state.

35. *Cap Cement for Temperatures from* 212° *to* 300° *Fahr.*—For cementing glass tubes, necks of balloons, etc., into metal mountings, where the apparatus is to be exposed to heat, a mixture of equal parts of red and white lead is preferable to white lead alone. If possible the surface of the glass should be roughened, and a little tow wrapped round the part where the cement is to be applied. This cement takes some time to acquire its full degree of hardness. In a week it will stand boiling water; in a month it will resist steam at 300°.

Casein Cements.

Casein or cheese has long been used for forming cements, either in combination with quick-lime, borax, or more recently, with silicate of soda. The most important point that requires attention, in order to secure success, is the freeing of the casein from all oily matter. Therefore, when curd is prepared from milk, use only the most carefully skimmed milk, quite free from cream. When cheese is used, select the poorest and wash it carefully.

36. *Cheese Cement for Mending China, etc.*—Take skim milk cheese cut it in slices and boil it in water. Wash it in cold water and knead it in warm water several times. Place it warm on a levigating stone and knead it with quicklime. It will join marble, stone or earthenware so that the joining is scarcely to be discovered. *See Parabolic Cement.*

37. *Casein and Soluble Glass.*—Casein dissolved in soluble silicate of soda or potassa, makes a very strong cement for glass or porcelain. Take casein, free from fat, and washed until no longer acid, and silicate of soda solution (waterglass) of each as much as may be needed. Fill a bottle to one-fourth of its

height with damp casein; then fill the flask with silicate of soda (waterglass), and shake frequently until the casein is dissolved.

38. *Casein Mucilage.*—Take the curd of skim-milk (carefully freed from cream or oil), wash it thoroughly and dissolve it to saturation in cold concentrated solution of borax. This mucilage keeps well, and as regards adhesive power, far surpasses the mucilage of gum arabic. It forms a valuable preparation for the laboratory, as when spread on strips of bladder it may be used to stop cracks in glass vessels, and will resist considerable heat.

39. Add ½ pint of vinegar to ½ pint skimmed milk; when the curd has settled pour off the liquid, and wash the curd until free from acid. Add the whites of five eggs and beat thoroughly; mix with sufficient finely powdered quicklime to form a paste. This is an excellent cement for mending glass and earthenware. It resists water and a moderate degree of heat.

Chemical Cement.

40. Melt yellow beeswax with its weight of turpentine, and color with finely powdered Venetian red. When cold it has the hardness of soap, but is easily softened and moulded with the fingers, and for sticking things together temporarily it is invaluable.

The consistence of the cement may be varied by changing the proportions of turpentine and wax, and if a very firm cement is needed, a little resin may be added.

Chinese Cement—Schio-liao.

41. To three parts of fresh beaten blood are added four parts of slaked lime and a little alum; a thin, pasty mass is produced, which can be used immediately. Objects which are to be made specially water-proof are painted by the Chinese twice, or at the most three times. Dr. Scherzer saw in Pekin a wooden box which had travelled the tedious road via Siberia to St. Petersburg and back, which was found to be perfectly sound and water-proof. Even baskets made of straw became, by the use of this cement, perfectly serviceable in the transportation of oil. Pasteboard treated therewith receives the appearance and strength of wood. Most of the wooden public buildings of China are painted with schio-liao, which gives them an unpleasant reddish appearance, but adds to their durability. This cement was tried in the Austrian Department of Agriculture, and by the "Vienna Association of Industry," and in both cases the statements of Dr. Scherzer were found to be strictly accurate.

Chinese Glue.

42. Shellac dissolved in alcohol. Used for joining wood, earthenware, glass, etc. This cement requires considerable time to become thoroughly hard, and even then is not as strong as good glue. Its portability is its only recommendation.

Coppersmith's Cement.

43. Powdered quicklime mixed with bullock's blood and applied immediately. *See Chinese Cement.*

Corks, Cement For

44. To render corks impervious to air, acids, alkalies and corrosive liquors generally, boil them for some time in melted paraffine. They must be kept under the surface of the melted material, and should be heated and allowed to cool several times, so as to get all the air out of the pores. Corks thus treated cut easily and make very close joints. For cements for coating cork, see *Bottle Cement.*

Curd Cement. *See Casein.*

Cutler's Cement.

This is the name given to various kinds of cement used for fastening knives, etc., in their handles.

45. A very firm cement is made of 4 parts resin, 1 of beeswax, into which, when melted, 1 part of fine brick dust is stirred. It adheres with great firmness.

46. Take powdered resin and mix with it a small quantity of powdered chalk, whiting or slaked lime. Fill the hole in the handle with the mixture, heat the tang of the knife or fork, and thrust in. When cold it will be securely fastened.

47. Take one lb. resin and 8 oz. sulphur, melt together, form into bars, or when cold reduce to powder. One part of the powder is to be mixed with half a part of iron fillings, brick dust or fine sand; fill the cavity of the handle with the mixture and insert the tang, previously heated.

48. Pitch, 4 parts; resin, 4; tallow, 2; brick dust, 2. Melt the first three ingredients and add the brick dust hot and finely powdered.

49. Chopped hair, flax, hemp or tow, mixed with powdered resin and applied as above.

Diamond Cement. *See Armenian Cement.*

Dextrine.

50. This is prepared from starch by the action of heat, diastase, or acids, and is sometimes called *starch gum* and *British gum.* As usually sold, it is a whitish, insipid powder, having a pleasant odor of cucumbers. It is soluble in cold and hot water, and in very dilute alcohol, but it is insoluble in strong alcohol and ether.

In France it is largely employed by pastry cooks and confectioners, and by surgeons, as a stiffening for the splints used for fractured limbs. It has also been made up into roundish masses and sold for gum Arabic.

It is said to be used by the British for "gumming" their postage stamps, but careful trial has convinced us that the best specimens in market are not equal to good gum Arabic. It is cheaper, however, and for ordinary purposes is strong enough.

Dextrine is easily prepared for use. It may be mixed with cold water and stirred or beaten for a few moments, when it will dissolve very completely. It may be used immediately, or it may be boiled. This we think improves it.

Egg Cement.

A number of very cohesive cements, impervious to water and most liquids and vapors, for a short time, are made by the union of quicklime with many of the vegetable and animal mucilages and glues. The following is said by Aiken to have been extensively employed by chemists for centuries under the name of "egg cement."

51. Take some white of eggs with as much water, beat them well together, and sprinkle in sufficient slaked lime to make the whole up to the consistence of thin paste. This cement sets or becomes hard very quickly, and must be used at once. It is employed to mend earthenware, china, glass, marble, alabaster, spar ornaments, etc. Although waterproof to a certain extent, it does not resist moisture long unless it has been exposed to heat.

52. Take freshly burnt plaster-of-Paris, 5 parts; freshly burnt lime, 1 part; white of egg as much as may be needed. Reduce the two first ingredients to a very fine powder and mix them well; moisten the two surfaces to be united with a small quantity of white of egg, to make them adhesive; then mix the powder very rapidly with white of egg, and apply the mixture to the broken surfaces. If they are large, two persons should do this, each applying the cement to one portion. The

pieces are then firmly pressed together, and left undisturbed for several days.

Elastic Cement.

53. *Lenher's Elastic Cement.*—Caoutchouc, 5 parts; chloroform, 3 parts; dissolve and add powdered gum mastic, 1 part. Elastic and transparent.

54. Cut india rubber into fine shreds and dissolve together 1 ounce of the rubber, 4 ounces of bisulphide of carbon, 2 drachms of isinglass, and ½ half ounce of gutta percha; in using this the parts to be joined must be covered with a thin coat of the solution, and be allowed to dry a few minutes; then heat to melting, place the parts together and compress until cold; this is useful for cementing leather or india rubber. (Doubtful).

55. Gutta percha, 1 lb; caoutchouc, 4 oz; pitch, 2 oz; shellac, 1 oz; linseed oil, 2 oz; melt together. Must be heated when applied.

Electrical Cement. *See Cap Cement.*

Extemporaneous Cement.

This term is applied to almost pure shellac and mastic. *See Shellac and Armenian Cement.*

Faraday's Cap Cement. *See Cap Cement.*

Fire-Proof Cement.

It is easy to find a *recipe* for a fire-proof cement, but it is very difficult to find a cement that will stand a red heat. It is well to bear in mind the fact that no cement containing organic matter (such as glue, flour, oil, etc.), can maintain any adhesive power at a red heat, since all such substances are decomposed at that temperature. Cements containing oil, etc., may do to fill cracks, but not to hold two surfaces together. We know of no cement that can be depended upon for this purpose to any great extent. For some purposes the glass cements Nos. 60 and 61 answer very well.

56. Often a cement is required to join the covers to crucibles, or for similar purposes, so as to keep them air tight when hot. A very valuable composition of the kind is made of glass of borax, (fused borax), brick dust and clay, finely powdered together and mixed with a little water when used. No very great nicety is required in the proportions but about a tenth of borax is quite sufficient to bring the earths to that state of semi-

vitrification which is desired. Litharge may be used instead of borax, but the latter is by far the best, as it promotes that thin spreading fusion which is most efficient.

57. A cement which is said to be useful, for stopping cracks in iron vessels which are intended to be strongly heated, is made of 6 parts of clay, 1 of iron filings, and linseed oil enough for mixture. The oil will, of course, be speedily destroyed, but will leave enough carbonaceous residue to unite the remainder into a firm mass.

We should prefer, however, to depend on the iron cement of which the formula is given in Nos. 92, 93 and 94.

58. The following cement is said to be very hard, and to present complete resistance alike to a red heat and boiling water: To four or five parts of clay, thoroughly dried and pulverized, add two parts of fine iron filings free from oxide, one part of peroxide of manganese, one half of common salt, and one half of borax; mingle thoroughly; render as fine as possible; then reduce to a thick paste with the necessary quantity of water, mixing well. It must be used immediately. After application it should be exposed to warmth, gradually increasing almost to a white heat.

Fish Glue.

Isinglass is sometimes called by this name, but will be found described under its own heading. There is also a coarse variety of glue prepared from fish, which will be found described under the heading, "*Glue, Fish.*" *See also*, "*Glue, Lapland.*"

French Cement.

59. Mix thick mucilage of gum arabic with powdered starch; a little lemon juice is sometimes added. Used by naturalists in mounting specimens; by artificial-flower makers, and by confectioners to stick paper ornaments, wafers, papers, etc., on their fancy cakes.

Glass Cement.

There are two kinds of so-called glass cement, and both are said to be very excellent for uniting broken glass, china, etc.

60. Take pulverized glass, 10 parts; powdered fluorspar, 20 parts; soluble silicate of soda, 60 parts. Both glass and fluorspar must be in the finest possible condition, which is best done by shaking each, in fine powder, with water, allowing the coarser particles to deposit, and then to pour off the remainder, which holds the finest particles in suspension. The mixture must be made very rapidly, by quick stirring, and when thor-

oughly mixed must be at once applied. This is said to yield an excellent cement.

61. Take red lead, 3 parts; fine white sand, 2 parts; crystallized boracic acid, 3 parts. These ingredients are mixed and fused, and then reduced to a very fine powder which may be made into a paste with a dilute solution of soluble glass, and applied as an ordinary cement, or it may be mixed with very weak gum water, (just enough gum to make it adhesive), after it has been applied, the articles are exposed to a heat sufficient to melt the fusible glass, which is formed by the union of the three ingredients.

Glass, Transparent Cement For *See Canada Balsam.*

Glue.

62. Glue is, undoubtedly, the most important cement used in the arts. It serves to unite wood, paper, and almost all organic materials. The carpenter, the cabinet maker, the bookbinder, the hatter, and numerous other trades use it extensively, and in some cases to the exclusion of everything else. Good glue, properly prepared and well applied, will unite pieces of wood with a degree of strength which leaves nothing to be desired. The fibres of the hardest and toughest wood will tear asunder before the glued surfaces will separate, and certainly anything more than this would be unnecessary. Mr. Bevan found that when two cylinders of dry ash, each an inch and a half in diameter, were glued together, and then torn asunder after a lapse of twenty-four hours, it required a force of 1260 lbs. to separate them, and consequently the force of adhesion was equal to 715 lbs. per square inch. From a subsequent experiment on solid glue he found that its cohesion is equal to 4000 lbs. per square inch. This would indicate that our methods of applying this substance as a cement are capable of improvement, and it is undoubtedly true that great care and skill must be used if the best results would be obtained.

Good glue is hard, clear (not necessarily light-colored, however,) and free from bad taste and smell. Glue which is easily dissolved in *cold* water is not strong. Good glue merely swells in cold water and must be heated to the boiling point before it will dissolve thoroughly. Good glue requires more water than that which is poor, consequently, you cannot dissolve six pounds of good glue in the same quantity of water you can six pounds of poor glue. The best glue, which is clear and red, will require from one-half to more than double the water that is required with poor glue. From careful experiments with dry glue immersed for twenty-four hours in water at 60° Fahr., and

thereby transformed into a jelly, it was found that the finest ordinary glue, or that made from white bones, absorbs twelve times its weight of water in twenty-four hours; the glue from dark bones, absorbs nine times its weight of water, while the ordinary glue made from animal refuse, absorbs but three to five times its weight of water.

The quality of glue may, to a certain extent, be estimated by breaking a piece. If good, it will break hard and tough, and when broken will be irregular on the broken edge. If poor, it will break comparatively easily, leaving a smooth straight edge.

Glue is insoluble in alcohol, though a small quantity of alcohol may be mixed with the solution without difficulty; but if too much alcohol be used, the glue separates from the water and falls to the bottom of the vessel in the form of a white viscid substance. Neither does it dissolve in ether, or in the fixed, or the essential oils, although oily matters of all kinds may be incorporated with the solution of glue forming a sort of emulsion. These facts will enable our readers to judge of the value of those recipes in which they are directed to dissolve glue in alcohol or in oil, for the purpose of making a glue which will remain liquid at all times. A little alcohol may be added, but if the amount of alcohol be sufficient to produce any marked effect, the glue is apt to separate. One of the most marked characteristics of good glue is its property of gelatinizing. By this is meant the fact that a moderately strong solution of glue which is quite fluid when hot, forms a stiff jelly when cold. This property is no bad test of the quality of glue. The firmer the jelly the better the glue. In ignorance of this principle, some persons have made great efforts to get rid of this property, and acids and various salts have been added to the solution of glue for the purpose of preventing its gelatinization, and thus retaining it in a liquid form that would be ready for use at any moment. But by those who have devoted the most careful attention to the subject, the fact stands unquestioned that the strongest glue is that which is purest and which gelatinizes or sets most completely.

Glue being an animal substance, it must be kept sweet, and free from putrefaction; to do this it is necessary to keep it cool after it is once dissolved, and while not in use.

The most serious defects in glue are the mixture of extraneous matters and incipient putrefaction. There are other substances, beside gelatin, present in the matters from which glue is prepared, and unless these substances are carefully separated the glue will prove of inferior quality. Hence, in selecting glue, choose that which is transparent and free from clouds or

flocks in its substance. Very clear and colorless glue is by no means the best, but, whatever be the color, see that it is clear. It is true that in some cases very finely divided powders have been added to glue with the avowed object of rendering it stronger. We feel inclined to believe, however, that such additions serve merely to cloak defects in the glue itself, or in the mode in which it is applied. Peter Cooper is said to add very finely divided Paris white to his glue, and it is claimed that the glue is improved not only in appearance but in actual strength. How this may be we know not. White-lead added to glue is said to make it water-proof as well as to strengthen it, and from the well-known relation of white-lead to oils and animal substances it is not impossible that this may be the case. For our own part, however, we have always found good pure glue equal to any requirements which we might demand of it.

The other, and by far the greatest and most common defect in glue is incipient putrefaction. This may occur either at the glue-factory or in the workshop of the mechanic; and in either case it is fatal to the strength of the glue. It may often be detected, however, by the smell and taste. The odors of good glue and of that which has begun to decay are so different that, once observed, they will never be forgotten. Glue which has begun to putrefy at the factory may not exhibit any odor so long as it is kept perfectly dry, and it may even have been so deodorized by bone black or the action of chemicals, that it does not exhibit a bad odor when first moistened. But when allowed to stand for a very short time, especially in warm weather, putrefaction again commences, and the odor is quite perceptible, while good glue will remain sweet and sound under the same conditions.

Glue which exhibits a bad odor when moistened, should be rejected and used only for making size, and for uniting the coarser varieties of articles; and when the glue-pot begins to exhibit any signs of putrefaction, it ought to be carefully cleaned out and thoroughly soaked and washed, for putrefaction acts likes a ferment, and the presence of a little bad glue will soon destroy a whole batch of a good article.

The preparation of glue demands care rather than skill. In dissolving glue, it is best to weigh the glue, and weigh or measure the water. If not done there is a liability of getting more glue than the water can properly dissolve. It is a good plan, when once the quantity of water that any sample of glue will take up has been ascertained, to put the glue and water together at least six hours before heat is applied, and if not soft enough then, let it remain longer in soak, for there is

no danger of good glue remaining in pure water, even for forty-eight hours, provided the weather be cold, but it must not be allowed to lie too long in that liquid or it will begin to decay, especially in warm weather. To meet this difficulty, and secure the quick soaking of the glue, there has of late years been introduced a pulverized or granulated article which is very excellent. Frozen glue, made porous by freezing, is also used with this object in view. After being soaked the glue should be melted, great care being taken that it be not burned. Next to putrefaction, burning is the great destroyer of glue. Burnt glue is always weak. If kept dry, glue may be preserved for any length of time, but when once moistened even the best samples soon spoil. No more glue should be prepared at any one time than is to be used immediately, and whenever a job requiring extra strength is to be executed, it will always pay to prepare a fresh lot. Formerly, when glue was generally heated over the naked fire the old-fashioned glue-pot was always used. This pot is double—the space between the outer and inner vessels being filled with water. Consequently where this pot is employed, the glue can never be made hotter than boiling water, and thus all danger of burning is avoided. Now that more delicate and convenient modes of heating have been devised, this old pot has in some cases been dismissed, to the evident deterioration of the process. Even steam should never be employed except to heat water in the outer case. In applying glue it should be remembered that the thinner the layer which is applied the stronger will be the joint, and the less water there is combined with the glue the sooner will it dry, and consequently the less will the joint be exposed to accidental disturbance before union has fairly occurred. Carpenters should remember that fresh glue dries more readily than that which has been once or twice melted.

If glue is of first-rate quality, it can be used on most kinds of woodwork very thin, and make the joint as strong as the original, but it is necessary that the glue be brought into intimate contact with the entire surface of the wood. The necessity for this has been fully explained in our introduction.

A drop of melted glue allowed to simply fall on a surface of dry, cold wood and dry there, will often fail to adhere at all, while if the same drop had been rubbed in, it would have attached itself to the surface with wonderful tenacity. In applying glue, therefore, we must secure this perfect contact, and we must also employ every means in our power to delay the gelatinization of the glue until the joint has been completed. The glue should therefore be used while very hot, as hot as it

will bear, and in very cold weather the wood itself should be warmed The glue should be well rubbed in with a stiff brush and the two surfaces should be rubbed well together and retained in contact under great pressure until the glue has become somewhat dry. Complete dryness rarely takes place under several days; but after the lapse of twelve hours the joint becomes tolerably strong. A joint made in this way is probably as strong as can be made by any ordinary process.

Glue, Fish.

63. An attempt has been made to prepare glue from the skins and refuse of fish in the same way that ordinary glue is prepared from the skins and offal of land animals Such glue has been made in large quantity, and forms a very good size for some purposes. Thus far, however, it has been found impossible to free it from a very disagreeable fish-like odor, and another objection is, that it does not gelatinize. It is probable that by exercising greater care and by using the skins alone, freeing them from scales and oil, a very strong and serviceable glue might be prepared. The ordinary method at present in use for curing fish, will, probably, at no distant day, give place to others by which the product will be more condensed and more palatable. In that case it is probable that fish skins will be an important part of the refuse, and a method of obtaining good glue from them will be a most valuable process. That there is no inherent difficulty with mere fish product is shown by the manufacture of isinglass, which is one of the strongest glues that we have. The northern seas will probably be the chief seats of this new industry, as the skins can then be subjected to the processes required, without such danger from putrefaction as exists in warm climates. *See Glue, Lapland.*

64. A correspondent of one of our technological papers describes a method of preparing glue from fish scales. We have never tried it, but give his account of it for what it is worth. He says: "The natives of the Maldive and Lacadive Islands, and the Malays, of the coasts of Borneo and Sumatra, have a glue which they make as follows:—They take the scales of a kind of fish, called by English and American sailors, salt-water trout, (identical with the salt-water trout of the Gulf of Mexico), and after thoroughly washing them in a glazed earthen jar, which they stopper tightly, and weight so that it will remain under water, they put this jar in a pot of water, and boil it until the scales are reduced to a semi-transparent viscous mass. This requires several hours' boiling. Care should be taken that no water or extraneous matter, fluid or solid, be allowed to get into the jar with the scales. The glue thus made

is the most tenacious, and at the same time the most transparent and beautiful that I have ever seen. I have made it in this country from the scales of perch, trout, and bass. I am informed that a similar glue is made from the bladders of various fishes."

Glue, Lapland.

65. The bows of the Laplanders are composed of two pieces of wood, glued together. One of them is of birch, which is flexible, and the other of the fir of the marshes, which is stiff, in order that the bow when bent may not break and when unbent it may not bend. When these two pieces are bent, all the points of contact endeavor to disunite themselves, and to prevent this the Laplanders employ the following cement: They take the skins of the largest perches, and having dried them so that the greasy part may be removed by scraping and wiping, and the oil soaked out by any porous material, they soak them in water until they are so soft that they may be freed from the scales, which are thrown away. They then put four or five of these skins in a reindeer's bladder, or they wrap them up in the soft bark of the birch tree, in such a manner that water cannot touch them, and place them thus covered in a pot of boiling water with a stone above them to keep them at the bottom. When they have boiled about an hour, they take them from the bladder or bark, and they are then found to be soft or viscous, like strong glue. In this state they employ them for glueing together the two pieces of their bows, which they strongly compress together and tie up until the glue is well dried. These pieces never afterward separate. *See Glue, Fish.*

Glue, Liquid.

Various attempts have, as we have already stated, been made, with the intention of retaining the glue in a liquid form, and of thus avoiding the inconvenience attending the use of a cement which requires to be liquified by heat whenever it is to be used. The addition of a little nitric acid will prevent the glue from gelatinizing or becoming solid, and the same effect is produced by the addition of a little vinegar, or, rather of pyroligneous acid, which will also prevent it from moulding. It is supposed that the latter is substantially the formula for making the well-known Spaulding's glue. The addition of these substances injure the glue, however. Spaulding's glue may be

more convenient than common glue, but it is far inferior to it in strength. More recently it has been proposed to add sulphate or chloride of zinc to common glue for the purpose of keeping it liquid. We have never tried it, but we have no faith in it. A solution of shellac in alcohol has been used and highly extolled as a substitute for common glue. It forms a tolerable liquid cement, but is far inferior to glue. Any of the following recipes will afford a liquid glue which will answer well enough for purposes where no great strength is required; but we know of no cement which is more convenient than common glue, and yet which will unite wood with anything like the efficiency of that article.

66. *Dumoulin's Liquid and Unalterable Glue.*—This is one of the oldest forms and one of the best; it is prepared as follows: Soak 8 oz. of best glue in ½ pint of water in a wide-mouthed bottle and melt by heating the bottle in a water-bath. Then add slowly 2½ oz. of nitric acid, spec. gr. 1·330, stirring constantly. Effervescence takes place under escape of nitrous acid gas. When all the acid has been added, the liquid is allowed to cool. Keep it well corked, and it will be ready for use at any moment. It does not gelatinize, or putrefy, or ferment. It is applicable to many domestic uses, such as mending china, wood, etc.

67. *Liquid Glue.*—A very strong glue may be made by dissolving 4 ounces of glue in 16 ounces of strong acetic acid by the aid of heat. It is semi-solid at ordinary temperatures, but needs only to be warmed, by placing the vessel containing it in hot water for a short time, to be ready for use.

68. Dilute officinal phosphoric acid with two parts, by weight, of water, and saturate with carbonate of ammonia; dilute the resulting liquid, which must be still somewhat acid, with another part of distilled water, warm it on a water-bath, and dissolve in it enough good glue to form a thick, syrupy liquid. It must be kept in well-closed bottles.

69. *Spaulding's Glue.*—This is simply good glue prepared with strong vinegar instead of water. Dilute, rectified pyroligneous acid, which is a coarse form of vinegar containing a very little creosote, may be used. It prevents mould and fermentation.

70. Glue, water and vinegar of each 2 parts. Dissolve in a waterbath and add alcohol 1 part.

71. A solution of shellac in alcohol is often sold under the name of "liquid glue." *See Chinese Glue.*

72. Macerate 6 parts of glue in 16 parts of water, until the glue is swollen and soft. Add 1 part of hydrochloric acid, and 1½ parts sulphate of zinc, and let the mixture be kept for ten or twelve hours at a temperature of 68° to 70° Cent. (154° to 158° Fahr.) Answers admirably for attaching labels to tin and to glass when exposed to damp.

73. The writer of the following claims to have a personal knowledge of its excellence: "An excellent liquid glue is made by dissolving glue in nitric ether. The ether will only dissolve a certain amount of the glue: consequently, the solution cannot be made too thick. The glue thus made is about the consistency of molasses, and is doubly as tenacious as that made with hot water (?). If a few bits of india-rubber, cut into scraps the size of a buck-shot, be added, and the solution allowed to stand a few days, being stirred frequently, it will be all the better, and will resist dampness twice as well as glue made with water."

Glue, Mouth or Lip.

Mouth glue forms a very convenient portable cement of considerable adhesiveness. For some purposes, especially for attaching drawing paper to a board, it is the most convenient form, but for ordinary desk use, the mucilage bottle is to be preferred. Mouth glue may be purchased in cakes from the dealers in artists' supplies. Those who attempt to make it themselves should use a very pure form of glue or gelatine, quite free from smell or taint, as this will prove very disgusting when the glue is moistened with the lips. Sugar is generally added, not for the purpose of sweetening the article, but to render it more soluble. It will be found that a pure, but dark brown sugar is better than a white article, and a little syrup or molasses better than either. When molasses is substituted for sugar the quantity employed may be greatly diminished.

We have often used a nice article of common glue instead of the so-called mouth glue. It requires a little more rubbing than the mouth glue, but it holds more strongly, and resists better the wetting to which mechanical and architectural drawings are subjected.

74. Soak 4 oz. best glue and 1 oz. isinglass in water until soft. Pour off the superfluous water, and add 1 oz. of brown sugar. Melt the whole together with a gentle heat, and allow it to evaporate until quite thick. Pour into a flat-bottomed dish that is quite cold; if placed on ice, so much the better, as it will prevent the glue sticking to it. When solid, cut into cakes.

75. Glue, 5 oz.; sugar, 1 oz.; dissolved in water, boiled down, poured into moulds and dried.

76. Take of isinglass and parchment glue, each one ounce; of sugar candy and gum tragacanth, each 2 drachms; add to them an ounce of water, boil the whole till the mixture appears, when cold, of the consistence of glue. Then form it into small rolls for use. This glue, wetted with the tongue and rubbed on the edges of the paper, silk, etc., to be cemented, will, on their being laid together and suffered to dry, unite them as firmly as any other part of the surface.

Glue, Portable.

77. Put a pinch of shredded gelatine into a wide-mouthed bottle; put on it a very little water, and about one-fourth part of glacial acetic acid; put in a well-fitting cork. If the right quantity of water and acid be used, the gelatine will swell up into worm-like pieces, quite elastic, but at the same time, firm enough to be handled comfortably. The acid will make the preparation keep indefinitely. When required for use, take a small fragment of the swelled gelatine, and warm the end of it in the flame of a match or candle; it will immediately "run" into a fine clear glue, which can be applied at once direct to the article to be mended. The thing is done in half a minute, and is, moreover, done well, for the gelatine so treated makes the very best and finest glue that can be had. This plan might be modified by dissolving a trace of chrome alum in the water used for moistening the gelatine, in which case, no doubt, the glue would become insoluble when set. But for general purposes, there is no need for subsequent insolubility in glue.

Glycerine Cement.

78. In 1869, Hirzel obtained, by triturating litharge with glycerine, a mass which he found useful as a cement for vessels containing benzol, ethereal oils, etc., as it possessed the property of soon hardening. During the same year, Pollack recommended the same mass as a cement for stone and iron ware, and pointed out that it was attacked only by strong acids; also, that its durability is the greater, the more water the litharge had absorbed, since the latter, when entirely dry,

yielded a cement of feeble adhesiveness only. Rost, in 1870, found this cement proof against concentrated [?] and diluted acids, alkaline lyes, ether, alcohol, benzol, and carbon disulphide.

The somewhat contradictory statements regarding the power of resistance against acids of this cement, as well as the desire to find out whether glycerine entered into a chemical combination with litharge, led Theodor Morawski to investigate the subject. He obtained a definite compound, crystallizing in fine needles, which was found to be a glyceride of lead.

From a large number of experiments instituted to ascertain the most favorable conditions for the production of a perfect cement, the author obtained the following results: The *hardest cement* is produced by triturating fifty grammes of litharge with five cubic centimetres of glycerine. If more glycerine is used, the mass hardens much more slowly and imperfectly.

The small proportion of glycerine, however, makes it impracticable to prepare large quantities of the cement at a time. For this purpose it will be necessary to take more glycerine, in order to facilitate the trituration. But as it was also proved that the addition of a small quantity of water produced an equally durable cement, provided the proper proportions are observed, he found, after many trials, that the most favorable results are obtained by adding 2 volumes of water to 5 volumes of glycerine (spec. gr. 1·240); 6 cubic centimetres of this liquid are incorporated with 50 grammes of litharge. This mass requires a shorter time than any other proportions to produce a hard cement, 10 minutes only being required to harden moderately, while, after 2 hours, it becomes even harder than any mixture containing litharge with glycerine alone. But, after a few days, the latter compound (prepared without water) overtakes the former in hardness and remains so. If it is desired to produce a cement which rapidly hardens, and still has considerable firmness, it is advisable to use water with the glycerine.—*Dingler's Polyt. Journal.*

The applications of this cement are innumerable. Chemists and others know well the difficulty of keeping very volatile liquids. Bottles of ether, for example, are shipped for India, and when they arrive are found to be more than half empty. The chemist sometimes puts a bottle of benzole or bisulphide of carbon on his shelves, and when he next requires it, he finds the bottle empty and dry. The usual remedy for this is a luting of melted sulphur, which is difficult to apply and hard to remove. Glycerine cement, however, is easily prepared and applied, and is said to prevent the escape of the most volatile liquids. It is merely painted around the cork or stopper. It

quickly dries, and becomes extremely hard, but can be easily scraped off with a knife, when it is necessary to open the bottle.

79. *Pollack's Formula.*—Take litharge and red lead, equal parts, mix thoroughly and make into a paste with concentrated glycerine to the consistence of soft putty. This cement takes some time to dry, but it turns almost as hard as stone, and resists moisture and heat very well. Mr. Pollack has used it to fasten the different portions of a fly-wheel with great success; while when placed between stones and once hardened, it is easier to break the stone than the joint.

Grinder's Cement. *See Optician's Cement and Turner's Cement.*

Gum Arabic—Gum Acacia.

80. Gum Arabic is the product of various species of Acacia. It is the material from which true mucilage is made, and it forms one of the most valuable cements that we have. Faraday tells us, in his work on "Chemical Manipulation," that there is no cement which exceeds it for strength.

Pure gum Arabic is in roundish or irregular pieces of various sizes more or less transparent, hard, brittle, and breaking with a shining fracture. It is usually white or yellowish white, but frequently presents various shades of red, and is, sometimes, of a deep orange or brownish color. In powder it is always more or less purely white.

It is liable to adulteration both in powder and in masses. Much of the white gum Arabic of the shops, consists of the cheaper and coarser gum Senegal, bleached by what is called "Picciotto's process." The gum is dissolved in water, and sulphurous acid gas passed through the solution. The liquid is afterwards boiled to expel the sulphurous acid, a little of which, however, still remains behind. The product is very white, but lacks the peculiar toughness and adhesiveness of the best gum Acacia.

The powdered gum is frequently adulterated with dextrine, gum Senegal, starch, sugar, cherry-tree gum, etc. These substances are not difficult of detection, but where a good article is required for preparing a cement, it is best to purchase gum Arabic in lump from a reliable dealer, taking care, in any case, to avoid the bleached article.

Powdered gum has no advantage, except in the fact that it dissolves more quickly than when in lumps. It, therefore, forms, when in this state, a very convenient and portable cement, which may be made ready in an instant by the addition of a little water.

For preparing gummed surfaces which will adhere when moistened (such as gummed labels, etc.), there is no material superior to gum Arabic.

The great difficulty with gum Arabic, and, indeed, with other gums and pastes, lies in the fact that when *thoroughly* dry, they become brittle, so that the label or other object falls off. A simple remedy for this difficulty lies in the addition of from five to ten drops of glycerine to each fluid ounce of mucilage or paste.

Gum Arabic is used not only alone, but when mixed with other matters. The following formulæ produce very good cements.

81. Rub together, in a mortar, two parts of nitrate of lime, twenty-five of water and twenty of powdered gum Arabic. This forms a transparent cement of great strength and applicable to wood, porcelain, glass and stone. The surfaces to be united should be painted with the cement and firmly bound together until the drying is complete.

82. A white paste, adhesive to most surfaces, is said to be made as follows: A solution of 2½ ounces gum Arabic in two quarts of warm water, is thickened with flour paste well boiled, and to this is added a solution of alum and sugar of lead, 720 grains each, in water; the mixture is heated and stirred till about to boil, and then cooled. It may be thinned, if necessary, with the gum solution. It will be seen that this mucilage consists of a solution of gum Arabic and flour paste in acetate of alumina, colored white with sulphate of lead.

83. To 250 grammes of mucilage prepared by dissolving 2 parts of gum in 5 of water, add 2 grammes of crystallized sulphate of aluminum dissolved in the least possible quantity of water. A solution of alum does not answer as well as the simple sulphate of alumina, which can be prepared from alum by precipitating the alumina with ammonia, washing thoroughly on a filter, and dissolving in sulphuric acid. The mucilage thus prepared does not sour or mould, and may be used as a cement for general purposes.

84. It is said that a mixture of one part of dry chloride of calcium, or two parts of the same salt in the crystallized form, and thirty-six parts of gum Arabic, dissolved in water to a proper consistency, forms a mucilage which holds well, does not crack by drying, and yet does not attract sufficient moisture from the air to become wet in damp weather.

Gum Tragacanth.

85. Known amongst mechanics as gum dragon and gum drag. It comes in irregular-shaped fragments, varying in size from that of a small pea to a hazel nut or larger. It is yellowish white, and sometimes translucent like horn. It is hard and tough, and very difficult to reduce to powder unless when exposed to a freezing temperature, or when thoroughly dried and ground in a heated mill or mortar. When so treated, however, it is possible to produce a very fine white powder. When thrown into water, it absorbs that liquid and swells up and forms a paste which is largely used by shoemakers, and by manufacturers of lozenges, as it gives great toughness to the mass of sugar and other ingredients.

If sufficient water be used, and the soft mass be heated or mixed up, it forms a uniform, soft, adhesive paste. If allowed to settle, however, part of the gum separates from the water, and is deposited. Boiling water dissolves the gum more perfertly at first, but even when so treated, it separates afterwards.

According to M. Planche, a mixture of gum tragacanth and gum Arabic forms, with water, a thinner mucilage than the same quantity of either of these gums alone.

86. Equal parts of tragacanth powder and powdered gum acacia (gum Arabic), moistened, according to requirements at the time, with dilute acetic acid, or, if the color will not be of any importance, with ordinary vinegar. This forms a very strong mucilage which keeps well.

Gutta Percha Cement. *See Aquarium Cement, No.* 9.

Hensler's Cement.

87. Litharge, 3 parts; quicklime, 2 parts; white bole, 1 part; grind up with boiled linseed oil. Forms a very tenacious and hard cement, but one that takes a long time to dry.

Hoenle's Cement. *See Shellac.*

India Rubber Cement.

88. Pieces of India rubber may be readily united by means of the pasty mass obtained by acting upon pure rubber by its appropriate solvents. These are: Sulphuric ether, coal-tar naphtha, bisulphide of carbon, caoutchoucin, and oil of turpentine. But as it is difficult to dissolve rubber, satisfactorily on the small scale, and as the cement may be bought ready made at a cheap rate, it is hardly worth while to enlarge upon its preparation. Those who wish to try it will probably succeed best by cutting pure rubber (not that which has been vulcanized) into very thin slices, boiling it in water so as to

soften and expand it, and then digesting it in hot coal-tar naphtha, or oil of turpentine. Several days are required to effect the solution.

When this cement is used for uniting pieces of rubber, the surfaces which are to be joined must be fresh; the surfaces should therefore be either pared with a knife or rasped with a file. They may then be coated with the cement, pressed firmly together, and exposed to a gentle heat for a few days.

89. For mending India rubber shoes, boots and apparatus where the regular rubber cement cannot be obtained, the following directions have been given: Cut 2 pounds caoutchouc into thin, small slices; put them in a vessel of tinned sheet-iron and pour over 12 to 14 pounds of sulphide of carbon. For the promotion of solution, place the vessel in another containing water previously heated up to about 86° Fahr. The solution will take place promptly but the fluid will thicken very soon, and thus render the application difficult, if not impossible. In order to prevent this thickening, a solution of caoutchouc and resin in spirits of turpentine must be added to the solution of caoutchouc in sulphide of carbon, and in such quantity that the mixture obtains the consistency of a thin paste. The solution of caoutchouc and resin in spirit of turpentine should be prepared as follows: Cut 1 pound of caoutchouc into thin, small slices; heat in a suitable vessel over a moderate coal fire, until the caoutchouc becomes fluid; then add ½ pound powdered resin and melt both materials at a moderate heat. When these materials are perfectly fluid, then gradually add 3 or 4 pounds spirit of turpentine in small portions, and stir well. By the addition of the last solution, the rapid thickening and hardening of the compound will be prevented, and a mixture obtained which fully answers the purpose of glueing together rubber surfaces, etc.

90. It is said that a good cement that will render India rubber in any form adherent to glass or metal, may be made as follows: Some shellac is pulverized, and then softened in ten times its weight of strong ammonia, whereby a transparent mass is obtained, which becomes fluid after keeping some little time, without the use of hot water. In three or four weeks the mixture is perfectly liquid, and, when applied, it will be found to soften the rubber. The rubber hardens as soon as the ammonia has evaporated again, and thus becomes impervious both to gas and to liquids. For cementing the rubber sheet, or the material in any shape, to metal, glass, and other such surfaces, the cement is strongly recommended.

Iron Cement.

91. Iron filings or borings when mixed with sulphur, sal ammoniac, etc., expand and form a compact mass which makes a very firm steam-tight joint if properly applied. Concerning this cement, Dr. Ure says: "The iron rust cement is made of from 50 to 100 parts of iron borings, pounded and sifted, mixed with one part of sal-ammoniac, and when it is to be applied, moistened with as much water as will give it a pasty consistence. Formerly, flowers of sulphur were used, and much more sal-ammoniac in making this cement, but with decided disadvantage, as the union is effected by oxidizment, and the consequent expansion and solidification of the iron powder and any heterogeneous matter obstructs the effect. The best proportion of sal-ammoniac is, I believe, 1 per cent. of the iron borings."

92. Mix 4 parts of fine borings or filings of iron, 2 parts of potter's clay, and 1 part of powdered potsherds, and make them into a paste with salt and water. When this cement is allowed to concrete slowly on iron joints, it becomes very hard.

93. *Iron Cement for Closing the Joints of Iron Pipes.*—Take of coarsely powdered iron borings, 5 pounds; powdered sal-ammoniac, 2 oz.; sulphur, 1 oz.; and water sufficient to moisten it. This composition hardens rapidly; but if time can be allowed it sets more firmly without the sulphur. It must be used as soon as mixed and rammed tightly into the joints.

94. Take sal-ammoniac, 2 oz.; sublimed sulphur, 1 oz.; cast-iron filings or fine turnings, 1 lb. Mix in a mortar and keep the powder dry. When it is to be used, mix it with twenty times its weight of clean iron turnings, or filings, and grind the whole in a mortar; then wet it with water until it becomes of convenient consistence, when it is to be applied to the joint. After a time it becomes as hard and strong as any part of the metal.

95. The following is said to form a very hard cement: Take a few spoonfuls of iron filings, and oxide of iron in the form of black scales which fall from red-hot bars of iron in blacksmith's shops: crush them fine with a hammer, mingle with the powder an equal bulk of the best Portland cement, and render the mass plastic by adding the white part of eggs, and work for a few minutes, until the plastic material is about of the consistence of soft putty. Only a small quantity should be prepared at once, as it will set in a short time.

96. A correspondent of the *English Mechanic* says that he has used the following recipe with the greatest suc-

cess for the cementing of iron railing tops, iron gratings to stoves, etc., and with such effect as to resist the blows of the sledge hammer:—"Take equal parts of sulphur and white lead, with about a sixth of borax, incorporate them so as to form one homogeneous mass. When going to apply it, wet it with strong sulphuric acid, and place a thin layer of it between the two pieces of iron, which should then be pressed together. In five days it will be perfectly dry, all traces of the cement having vanished, and the iron will have the appearance of having been welded together." Careful consideration of this recipe does not dispel from our mind all doubt in regard to its efficiency; but from the confident way in which it is put forward it may be well to give it a trial.

Isinglass.

97. This is probably the purest form of gelatin or animal glue, and it makes one of the strongest cements known. As a cement, it may be treated like glue. From the fact that it is made from the sounds of fishes, it is sometimes called *fish-glue.*

Ivory, Cement for.

The American or Diamond cement unites pieces of ivory with great firmness, but where a white cement, of nearly the same color as ivory is required, the following modification will be found useful.

98. Dissolve 1 part of isinglass and 2 parts of white glue in 30 parts of water; strain and evaporate to 6 parts, then add 1-30 part of gum mastic, dissolved in ½ part of alcohol, and add 1 part of zinc white. When required for use, warm and shake well. The broken edges to be joined must also be warmed.

Japanese Cement.

99. This is simply a paste made of fine rice flour, well boiled and ground in a mortar.

Jeweller's Cement.

100. It sometimes happens that jewellers, in setting precious stones, break off pieces by accident; in this case they unite the parts so that the joint cannot be easily seen, with gum mastic, the stone being previously made hot enough to melt it. By the same medium cameos of white enamel or colored glass, are often joined to a real stone as a ground, to produce the appearance of an onyx. Mastic is likewise used to cement false backs or doublets to stones, to alter their hue.—(*Ure*). The

term *Jeweller's Cement* is also applied to *Armenian Cement*, which see.

Kerosene Oil Lamps, Cement for.

101. The cement commonly used for fastening the tops on kerosene lamps is plaster-of-Paris, which is porous, quickly penetrated by the kerosene, and soon destroyed. Another cement which has not this defect is made by boiling three parts of resin, and one of caustic soda in five of water. This composition forms a soap, which, when mixed with half its weight of plaster-of-Paris, sets firmly in about three-quarters of an hour. It is said to be of great adhesive power, not permeable to kerosene, a low conductor of heat, and but superficially attacked by hot water.

Labels, Cement for.

102. The usual adhesive coating for "gum tickets," is the cheaper varieties of gum Arabic dissolved in water, applied with a brush and dried.

103. Mix dextrine with water, and add a drop or two of glycerine.

104. Labels that are exposed to acid fumes or damp, may be attached with any good paste, and when dry, coated with copal varnish. If neatly done the appearance is very good, and moisture and acids have no action on them.

105. For attaching labels to tin and other bright metallic surfaces, first rub the surface with a mixture of muriatic acid and alcohol; then apply the label with a very thin coating of the paste, and it will adhere almost as well as on glass.

106. To make cement for attaching labels to metals, take ten parts tragacanth mucilage, ten parts of honey, and one part flour. The flour appears to hasten the drying, and renders it less susceptible to damp.

107. Another cement that will resist the damp still better, but will not adhere if the surface is greasy, is made by boiling together two parts shellac, one part borax, and sixteen parts water.

108. Flour paste to which a certain proportion of nitric acid has been added, and heat applied, makes a lasting cement, but the acid often acts upon the metals. The acid converts some of the starch into dextrine.

109. Dissolve two drachms of isinglass in four ounces of distilled vinegar; add as much gum Arabic as will give it the required consistency. This mucilage keeps very well, but is apt to become thinner, when a little more gum may be added.

110. Dissolve isinglass in vinegar to a pretty thick consistence when warm. This congeals on cooling, and before it is used should be gently warmed.

111. A capital adhesive liquid for sticking tickets on glass, wood, or paper, is obtained as follows: About half an ounce of fine glue which has been a day before soaked in water, and some candy sugar, with half an ounce of gum Arabic, and three ounces of water, are placed in a small bowl over a spirit lamp, and continually stirred till the composition thoroughly boils and dissolves, and the mass becomes thin. When coated with this cement and then dried; the tickets, when moistened with the tongue, will stick with the greatest tenacity.

112. Dextrine, 2 parts; acetic acid, 1 part; water, 5 parts; dissolve in a water-bath and add 1 part of alcohol. Forms an excellent mucilage for stamps and labels that are to be kept ready gummed.

113. It is said that for the labels of seltzer or soda water bottles, the best paste is one made of good rye flour and glue to which linseed oil varnish and turpentine have been added in the proportion of half an ounce of each to the pound. The paste must be made quite hot, and the oil incorporated with it by thorough heating. Labels attached by this cement do not fall off in damp cellars.

Laboratory Cement.

114. Equal parts of pitch, resin and plaster-of-Paris united by fusion. Used for lining casks for holding chloride of lime, and for joining and coating the masonry of acid chambers, etc.

Lapland Glue. *See Glue, Lapland.*

Lead, Compounds of.

115. Simply pure white-lead ground in oil, and used very thick, is an excellent cement for mending broken crockery ware; but it takes a very long time to harden sufficiently. The best plan is to place the mended object in some storeroom, and not to look after it for several weeks, or even months. After that time it will be found so firmly united that, if ever again broken, it will not part on the line of the former fracture. It resists moisture and a heat not exceeding that of boiling water.

116. Take white lead, ground in oil, a sufficient quantity. Add dry red lead enough to make a stiff putty. Put the mass in a mortar or on a block of iron or smooth stone, and pound it till it becomes soft; continue to add red lead, and pound until the mass will no longer become softer by pounding, nor

stick to the fingers. At this time it should be of sufficient tenacity to stretch out three or four inches when pulled, without parting. The more protracted the pounding, the softer, finer, and more tenacious the cement becomes. Interpose this putty between the flanges of steam-pipe joints, taking care to put a thin grummet of packing or wicking around the diameter of the bore, to keep the cement from squeezing through when the flanges are screwed together. It is indestructible by steam or water, and makes the best joint known to the engineer.

117. Mix two parts of finely powdered litharge with one part of very fine sand, and one part of quicklime which has been allowed to slake spontaneously by exposure to the air. This mixture may be kept for any length of time without injuring. In using it a portion is mixed into paste with linseed oil, or, still better, boiled linseed oil. In this state it must be quickly applied, as it soon becomes hard.

Leather, Cement for.

118. One who has tried everything says, that after an experience of fifteen years he has found nothing to equal the following: Common glue and isinglass, equal parts, soaked for 10 hours in just enough water to cover them. Bring gradually to a boiling heat and add pure tannin until the whole becomes ropy, or appears like the white of eggs. Buff off the surfaces to be joined, apply this cement warm, and clamp firmly.

119. Mix ten parts of sulphide of carbon with one of oil of turpentine, and then add enough gutta percha to make a tough thickly-flowing liquid. One essential pre-requisite to a thorough union of the parts consists in freedom of the surfaces to be joined from grease. This may be attained by laying a cloth upon them and applying a hot iron for a time. The cement is then applied to both pieces, the surfaces brought in contact, and pressure applied until the joint is dry.

120. Another leather cement is made of gutta percha dissolved in bisulphide of carbon, the mixture being about the thickness of syrup; the parts to be cemented must be well coated, so as to fill the pores of the leather; then heat the cement and join the ends, hammering the parts until the cement is cold.

121. To cement leather to metal: Wash the metal with hot gelatine; steep the leather in an infusion of nut galls (hot) and bring the two together.

Letter Fixing Cement. *See Metal, Cements for.*

London Cement.

Cheese and quicklime. For method of preparation, see Casein Cement, No. 36.

Lut d' Ane. *See No.* 36.

Mahogany Cement.

The following cements are used to stop holes and cracks in mahogany furniture:

122. Beeswax, 4 oz.; melt and add Indian red, 1 oz.; and enough yellow ochre to produce the required tint.

123. Shellac melted and colored as above, very hard.

Maissiat's Cement. *See Bottle Cement.*

Marble, Cement for.

124. *Keene's Marble Cement.*—Baked gypsum or plaster-of-Paris, steeped in a saturated solution of alum, and then re-calcined and reduced to powder. For use it is mixed up with water as ordinary plaster-of-Paris. This preparation forms a stucco, rather than a cement. It take a high polish, and when colored is very beautiful, but does not unite pieces as strongly as number

125. An excellent cement for mending marble or any kind of stone, is made by mixing 20 parts of litharge and 1 part of freshly burned lime in fine dry powder. This is made into a putty by linseed oil. It sets in a few hours, having the appearance of light stone.

126. Resin, 8 parts; wax, 1 part; plaster-of-Paris, 4 parts; mix by fusion. The pieces to be joined must be made hot.

Marine Glue.

Marine glue is probably the strongest cement known, and when well made and properly applied it is capable of uniting wood, metal, glass, leather, etc., with a strength and durability that is astonishing. We have in our possession pieces of apparatus, the parts of which are united with this cement, and which we know to have been in existence over forty years, and which are as firm to-day as ever.

Marine glue is a combination of shellac and caoutchouc in proportions which vary according to the purposes for which the cement is to be used. Some is very hard, others quite soft. The degree of softness is also regulated by the proportion of naphtha used for dissolving the caoutchouc and shellac. It

is difficult to prepare it on the small scale, and is not usually found on sale in this country. The following is the formula for the ordinary variety:

127. India rubber (cut small), 1 part; coal tar naphtha, 12 parts; digest in a covered vessel with heat and agitation, and when the solution is complete, add of powdered shellac, 20 parts. Continue the heat and stirring until perfect liquefaction has taken place, and pour the fused mass, whilst still hot, on slabs of polished metal or stone so as to form thin sheets. When used it is to be heated to its melting point, (248° to 250° Fahr.), in an iron vessel and applied in the liquid state with a brush. Great care and considerable experience is necessary to enable any one to use this cement. If the solid cement be heated but a very few degrees above its melting point, it crumbles and becomes useless. We have succeeded by cutting it in shreds, placing these between the parts to be joined and heating the whole until the glue could be pressed into uniform contact with the entire surfaces. Sometimes it is convenient to use a form of the glue which is more fluid, from containing more naphtha. The following formulæ answers in such cases, but are not as strong as the ordinary marine glue.

128. Dissolve gum shellac three parts, and caoutchouc one part, in separate vessels, in ether free from alcohol, applying a gentle heat. When thoroughly dissolved, mix the two solutions. Use rectified sulphuric ether that has been washed to remove alcohol and acidity, and India rubber that has not been vulcanized. When the caoutchouc has become well softened by the ether, break it up into small pieces and stir well until a homogeneous soft mass is obtained. It will be as well to cut the rubber into small pieces before pouring the ether on them, but the mass must be frequently and well stirred. Pour the solution of shellac into that of the rubber, and incorporate them thoroughly by stirring.

This is a modification of the famous marine glue, and resists the action of water, both hot and cold, and most of the acids and alkalies. If the glue be thinned by the admixture of ether, and applied as a varnish to leather, along the seams where it is sewed together, it renders the joint or seam water-tight, and almost impossible to separate.

129. The following recipe, taken from *New Remedies*, is said to yield a strong cement: 10 parts of caoutchouc or India rubber, are dissolved in 120 parts of benzine or petroleum (?) naphtha with the aid of a gentle heat. When the solution is complete, which sometimes requires 10 to 14 days, 20 parts of asphalt are melted in an iron vessel, and the caoutchouc solu-

tion is poured in very slowly, in a fine stream, and under continued heating, until the mass has become homogeneous, and nearly all of the solvent has been driven off. It is then poured out and cast into greased tin moulds. It forms dark-brown or black cakes, which are very hard to break. This cement requires considerable heat to melt it; and to prevent it from being burnt, it is best to heat a capsule containing a piece of it first on a water-bath, until the cake softens and begins to be liquid. It is then carefully wiped dry, and heated over a naked flame, under constant stirring, up to about 300° F. The edges of the article to be mended should, if possible, also be heated to at least 212° F., so as to permit the cement to be applied at leisure and with care. The thinner the cement is applied, the better it binds.

Mastich Chaud.

This term is applied by the French to those resinous cements which are liquid when hot, and which become more or less solid by cooling. Of these, common sealing-wax is the most useful.

Meerschaum, Cement for.

The best cement for joining pieces of meerschaum, is *Egg Cement*, which see.

Metal, To Cement to Glass, Stone, etc.

For attaching metal plates, such as letters, etc., to flat sheets of glass the following may be used.

130. Copal varnish, 15; drying oil, 5; turpentine, 3. Melt in a water-bath and add 10 parts slaked lime.

131. Copal varnish, 15 parts; boiled linseed oil, 5; Venice turpentine, 5; glue melted in the smallest possible quantity of water, 5 parts. Melt together and add 10 parts of powdered quicklime.

132. Carpenter's glue, 4 parts; Venice turpentine 1 part.

Mucilage. *See Gum Arabic.*

Milk Cement.

133. This cement is not so generally known as it ought to be. It is the simplest and best domestic cement for repairing china and crockery. The process consists simply in tying the parts firmly together and boiling them in skim milk. The tying together of the pieces of a round cup or bowl is not a very simple matter, but it can be done by going the right way to work. First, arrange the parts in their proper positions, and, if a bowl, set it mouth down, as the pieces will keep their

arrangement best in this position. Then wind stout tape round the article, so as to hold the pieces together. Tape is far better than twine, and some pieces should be kept for this purpose. It is easy to draw the tape tight until we come to tie the ends, and then special devices must be used. When sufficient tape has been wound round the article, let one person hold it from slipping, by pressing a finger firmly on each end, and then let another person tie the ends in a firm knot, but leaving the tape so loose from the article that a pencil or stout skewer may be passed under it. Then by twisting the skewer the tape is tightened in the same way that a surgeon compresses an artery with his tourniquet, and by passing the fingers over the tape, and smoothing it forward toward the ends, all the pieces may be pressed together with a firmness that cannot be obtained in any other way.

The article should now be placed in a pan of cold milk (skim-milk is the best and cheapest), which should be gradually heated to the boiling point, and kept at this temperature for some time—say half an hour to an hour—care being taken not to allow it to burn. The articles are allowed to cool in the milk, and when taken out are wiped dry and allowed to stand for a day or two until the cement has become quite hard. They may then be washed off with warm water, and the parts will be found to be strongly cemented together. The same milk may be used again, but not with such good effect. Generally, however, it is possible to pack quite a number of articles in the pan in the first place, especially if they can be *nested*, or placed one within the other.

Opticians' Cement.

The cements obtained from the following formulæ, are used by opticians for fixing lenses, prisms, etc., to chucks and holders, while they are being ground.

134. Pitch, 5 parts; wood ashes 1 part; tallow, 1 part, less or more, according to the temperature of the season.

135. Shellac softened with rectified spirit or wood naphtha.

136. Beeswax, 1 oz.; resin, 15 oz.; melt and add 5 oz. of whiting previously heated red hot and still warm.

137. Resin. 1 lb.; melt and add dry and warm plaster 4 oz. This forms a very strong cement for rough purposes.

Parabolic Cement.

138. This is a variety of casein or cheese cement, prepared as follows: Curdle skim-milk with rennet or vinegar, press out the whey, and dry the curd by a very gentle heat, but as quickly as possible. When quite dry grind it in a pepper or coffee

mill, and triturate it in a mortar until reduced to a very fine powder. Mix ten parts by weight of this powder with one part of quicklime, also in very fine powder, and to every ounce of the mixture add 5 or 6 grains of camphor. Triturate the whole well together and keep in phials well corked.

Used to unite glass, earthenware, etc., which it does very strongly. It is made into a paste with a little water as wanted, and applied immediately. *See Casein Cement.*

Parian Cement.

139. Same as Keene's marble cement, (see *Marble*), substituting a solution of borax for a solution of alum.

Paris Cement.

140. This cement is used for mending shells and other specimens of natural history. It is composed of gum Arabic, 5; sugar candy, 2. White lead, enough to color.

Paste.

Next to glue, paste is the most extensively used, and the most valuable cement that we have. For ordinary purposes it consists simply of flour, made into a thin cream with water and boiled. It then forms a stiffish mass which may be diluted with water so as to bring it to any required condition of thickness. There are two distinct elements in flour, both of which are valuable, one is starch, and the other is gluten. The cheaper kinds of flour, and especially rye flour, are rich in gluten while wheat flour is rich in starch. In the latter case it is sometimes of advantage to add a little common glue to the paste.

For ordinary purposes no additions are necessary, but where paste is to be kept for a long time, various ingredients may be added, to prevent souring and moulding. A few cloves form, perhaps, the best preservative for small quantities. On the larger scale carbolic acid may be used. If it were not for the expense, salicylic acid would form a good preservative.

According to the statement of Herr P. Lung, souring and moulding may be entirely prevented by the addition and thorough mixture with the freshly-prepared paste of a few grains of salicylic acid. When thus treated, a paste may be

kept for weeks in a heated room without losing its freshness, and even when it has, by long standing, become dry and tough, may be at once rendered fluid and serviceable by treatment with hot water. The addition of the acid does not, according to this author, affect the stickiness of the paste to any sensible degree.

When it is desired to prevent the attacks of insects, either before or after use, the addition of corrosive sublimate is a sure preservative, but as this substance is a powerful poison, great care must be exercised when it is employed. The following formulæ give good results.

141. *Starch Paste.*—This is best prepared by triturating the starch with cold water in a mortar until no lumps remain, and not too thick a mass is formed, and pouring into this boiling water very slowly, with rapid stirring, until the paste begins to form, as indicated by the increase of transparency, and then rapidly adding the rest of the boiling water necessary for the paste. Boiling the paste is very injurious, rendering it less adhesive, and liable to peel off. Rye flour affords a more adhesive paste than starch, but of a gray color. The addition of a little alum to the water with which paste is prepared renders it more permanent, and the use of boiling lime water instead of pure water adds to its adhesiveness. An aqueous extract of decomposed gluten, however, affords the best paste with starch. By incorporating with the paste a quantity of turpentine, equal in weight to half of the starch employed, and stirring well while the paste is still hot, it will be rendered more impervious to moisture, and at the same time more adhesive.

142. *Corn Starch Paste.*—Corn starch makes a good paste for scrap-books. Dissolve a small quantity in cold water, then cook it thoroughly. Be careful and not get it too thick. When cold it should be thin enough to apply with a brush. It is not so liable to mold and stain the paper as paste made from other kinds of starch.

143. *Paste for Mounting Photographs.*—Mix thoroughly 630 grains of the finest Bermuda arrowroot with 375 grains of cold water in a capsule, with a spoon or brush; then add 10½ ounces of water and 60 grains of gelatin in fine shreds. Boil, with stirring, for five minutes, or until the liquid becomes clear, and when cold stir in well 375 grains of alcohol, and five or six drops of pure carbolic acid. Keep in well-closed vessels, and before using it, work up a portion with a brush in a dish.

144. Four parts, by weight, of glue are allowed to soften

in 15 parts of cold water for some hours, and then moderately heated till the solution becomes quite clear. 65 parts of boiling water are now added with stirring. In another vessel 30 parts of starch paste are stirred up with 20 parts of cold water, so that a thin milky fluid is obtained without lumps. Into this the boiling glue solution is poured, with constant stirring, and the whole is kept at the boiling temperature. After cooling, 10 drops of carbolic acid are added to the paste. This paste is of extraordinary adhesive power, and may be used for leather, paper, or cardboard with great success. It must be preserved in closed bottles to prevent evaporation of the water, and will, in this way, keep good for years.

145. Fine wheat starch, 1 oz.; beat into a paste with cold water; best glue, 4 oz. Soak the glue, and when soft, boil it and add the starch paste, stirring well. Boil the whole until it is quite thick, and set aside to cool. It keeps well, and when required for use may be instantly dissolved in a little warm water.

146. Two ounces of starch, one ounce of white glue, half an ounce of acetic acid, a few drops of oil of cloves. Dissolve the glue in cold water and then boil. Mix the starch with cold water, and pour into the glue while boiling.

147. Rice flour makes an excellent paste for fine paper work.

148. Gum tragacanth and water make an ever ready paste. A few drops of any kind of acid should be added to the water before putting in the gum, to prevent fermentation. This paste will not give that semi-transparent look to thin paper, that gum Arabic sometimes gives, when used for mucilage.

Peasley Cement.

149. Many of our readers have seen a load of hay drawn by a span of horses, the whole got up for the purpose of making an exhibit and sale of the celebrated Peasley cement. "It will cement my leather traces if cut in two, so that they will be as strong as ever," the vender is wont to cry. A recipe for this cement was published in a well-known technological journal about the time of the first appearance of the cement. We doubt the accuracy of the formulæ, however, and believe that the Peaseley cement was merely a modification of the well-known Armenian cement, which see. The following is the recipe alluded to: Prepare a solution of two hundred parts of white glue in water; another one of fifty parts of isinglass, three of gum Arabic, and three of tragacanth; and finally, an-

other of one part of shellac in alcohol. Then pour these three solutions together, mix them with twenty-four parts of white lead, and add twelve parts of the best glycerine, and two hundred parts of alcohol. The mastic thus obtained should be immediately put up in bottles and well corked.

Persian Cement. *See Armenian Cement*, No. 4.

Plumbers' Cement.

150. Black resin, 1 part; brick dust, 2 parts. The brick dust should be finely powdered, thoroughly dried and added to the resin when the latter is in a melted state.

Porcelain Cement.

151. Add plaster-of-Paris to a strong solution of alum till the mixture is of the consistency of cream. It sets readily, and is said to unite glass, metal, porcelain, etc., quite firmly. It is probably suited for cases in which large rather than small surfaces are to be united.

Rubber Cement. *See India Rubber.*

Seal Engravers' Cement.

Used for fixing seals, etc., while being engraved. *See Opticians' Cement and Turners' Cement.*

Shellac.

152. Shellac, made up into sticks of the size of a lead pencil, is frequently sold as a cement which will resist water, acids, oils, etc., and it answers very well. Sometimes it is mixed with very fine powders either to give it body, or to color it. Zinc white or plaster-of-Paris may be used to make it white; ivory black, for black; brick dust, red ochre and vermillion for different shades of red.

The objects to be cemented together are first warmed till they melt the shellac brought in contact with them. This is very good to cement broken glass, porcelain, etc., especially as the objects are again ready for use immediately when cold; but it is not adapted for flexible objects, as it cracks. It will not withstand heat or alcohol, which softens the shellac.

Shellac is soluble in alcohol, when it forms what is known as Chinese glue. It is also soluble in wood naphtha. Contrary to published statements to that effect, (see Dick's "Cyclopædia of Recipes," No. 2156) shellac does not form as strong a cement when in the state of solution as when melted by heat.

Instead of using alcohol or benzine, a watery solution of borax may be used for dissolving shellac. Take of borax, 100

parts; rain (or distilled) water, 2,250 parts, heat to boiling, and while stirring, gradually add powdered shellac, 300 parts. When dissolved, strain through muslin and preserve. This forms a water-proof varnish. Paper soaked with this is water-proof and resembles parchment.

Shellac makes the best black cement for articles of jet. It is made black by smoking it in the flame of a lamp or candle.

153. *Hoenle's Cement.*—Shellac, 2 parts; Venice turpentine, 1 part; fuse together and form into sticks.

154. It is sometimes necessary to pulverize shellac, and any one who has tried to pound up shellac in a mortar knows that the attempt is more favorable to perspiration and profanity then to the pulverization of the slippery stuff. A correspondent of the *Druggists' Circular* has devised the following method: "Enclose the shellac in a strong, closely-woven piece of cloth, at first compressing the folds rather tightly, but gradually relaxing them. Then, after placing the bunch, which must be held in position with the hand, upon a solid block or smooth counter, the strokes of a heavy iron pestle are applied, gently at first, while the bunch is kept moving from side to side, so as to expose every part to the strokes of the pestel. After the large, sharp pieces are broken, the strokes are increased in velocity and power, with wonderful effect upon the resin, and but little injury to the cloth. In this way shellac may be reduced to a granular form sufficiently fine for pyrotechnic purposes at very short notice, and to an almost impalpable powder in a comparatively short space of time. To produce this result, however, it is necessary to wield the pestle forcibly, and then from time to time separate the finer particles from the coarser by sifting."

Schio-liao. *See Chinese Cement.*

Singer's Cement. *See Cap Cement.*

Soft Cement. *See Chemical Cement.*

Soluble Glass Cements.

155. When finely-pulverized chalk is stirred into a solution of soluble glass of 30° Baumé until the mixture is fine and plastic, a cement is obtained which will harden in between six and eight hours, possessing an extraordinary durability, and alike applicable for domestic and industrial purposes. It may be used for uniting stone, brick, etc., and for filling up cracks. In short, it seems to be applicable to about the same purposes for which plaster-of-Paris is used, but it is much harder and stronger. If for part of the chalk some coloring matter be substituted, differently colored cements of the same general

character are obtained. The following materials give good results:

156. Finely-pulverized or levigated stibnite (grey antimony, or black sulphide of antimony) will produce a dark cement, which, after burnishing with an agate, will present a metallic appearance.

156. Pulverized cast iron, a grey cement.

158. Zinc dust (so-called zinc grey), an exceedingly hard grey cement, which, after burnishing, will exhibit the white and brilliant appearance of metallic zinc. This cement may be employed with advantage in mending ornaments and vessels of zinc, sticking alike well to metals, stone, and wood.

159. Carbonate of copper, a bright green cement.

160. Sesquioxide of chromium, a dark green cement.

161. Thénard's blue (cobalt blue), a blue cement.

162. Minium, an orange-colored cement.

163. Vermillion, a splendid red cement.

164. Carmine red, a violet cement.

Sorel's Cement.

There are two different cements which go by the name of Sorel's Cement; namely, the "Oxychloride of Zinc Cement," and the "Magnesia Cement."

165. *Oxychloride of Zinc Cement.*—A solution of chloride of zinc is prepared by dissolving zinc in hydrochloric acid, so that some metallic zinc always remains undissolved. The solution is filtered and concentrated until it has the spec. grav. 1·800.

Commercial oxide of zinc is mixed with water containing 2 per cent. of nitric acid to a stiff paste, which, after being dried, is heated in crucibles to a white heat, after which it is reduced to an impalpable powder. The object of this baking is to reduce the oxide to as small a bulk as possible, in which condition it has more binding power. The powder must be kept from contact with the air, to prevent access of moisture and carbonic acid gas.

On bringing together the oxide and solution of chloride of zinc, the whole solidifies in a few minutes to a very hard mass. If it is desired to retard the hardening, the zinc solution may be diluted to about 1·500–1·600 spec. gr., and the oxide of zinc may be mixed with 2 to 3 per cent. of borax or chloride of ammonium.

166. *Magnesia Cement.*—This was originally prepared by Sorel, of Paris, from magnesite (chiefly native carbonate of magnesium), by making a paste with powdered magnesite, 10 to 20 per cent. of hydrochloric acid, and a sufficient quantity

of water, forming the mass into bricks, then burning them at a strong heat, and finally grinding them. This yields a very hard, bright-colored cement, which bears large dilution with sand, but is not entirely water-proof.

Since the immense saline deposits at Stassfurt have been worked, this cement is prepared from kieserite (a native hydrated sulphate of magnesium), many thousand tons of which are annually obtained. Kieserite is mixed with calcium hydrate, in the proportion of two molecules of the former to one of the latter, with addition of water; the mass is formed into bricks or cakes, dried, and "burnt," and powdered. The powdered mass when moistened solidifies to a marble-like mass, which does not, however, permanently resist moisture, and is best used only in the interior of buildings.

167. The following composition forms an excellent material for moulding or for uniting stone, etc. Mix commercial zinc white with ½ its bulk of fine sand, adding a solution of chloride of zinc of 1·26 specific gravity, and rub the whole thoroughly together in a mortar. The mixture must be applied at once, as it hardens very quickly.

Steam Cements.

The cements usually employed for making steam tight joints are composed of white lead and litharge in various proportions. *See Lead, Compounds of.*

168. A steam-tight cement which is said to be superior to the ordinary white and red lead cement, is obtained by mixing six parts of finely pulverized plumbago, three parts of slaked lime, eight parts of sulphate of barytes, and seven parts of boiled linseed oil. These ingredients must be intimately mixed.

Tragacanth. *See Gum Tragacanth.*

Transparent Cement. *See Canada Balsam.*

Turkish Cement. *See Armenian Cement*, No. 4.

Turners' Cement.

169. Melt 1 lb. of resin in a pan over the fire, and when melted, add a ¼ of a lb. of pitch. While these are boiling add brick dust until, by dropping a little on a cold stone, you think it hard enough. In winter it may be necessary to add a little tallow. By means of this cement a piece of wood may be fastened to the chuck, which will hold when cool; and when the work is finished it may be removed by a smart stroke with the tool

Any traces of the cement may be removed from the work by means of benzine.

170. The heat necessary to melt the ordinary turners' cement is liable to warp thin plates of brass, and in some cases, as for example circles of mathematical instruments that require to be graduated, this is very objectionable. In such cases plaster-of-Paris is the best cement to use.

Universal Cement. *See Parabolic Cement.*

Varley's Cement. *See Cap Cement.*

Waterproof Cement.

171. Glue to which bichromate of potash has been added and which has afterwards been exposed to strong sunlight, becomes insoluble. The proportions are not very well ascertained, but about one part of the bichromate, dissolved in water, and added to a solution of six parts of solid glue, answers very well.

The following is a valuable cement which, if properly applied, will be insoluble even in boiling water: Gelatin, 5 parts; soluble acid chromate of lime, 1 part. Cover the broken edges with this, press lightly together, and expose to the sunlight; the effect of the latter being to render the compound insoluble.

173. It is said by the British *Journal of Photography*, that the following recipe gives excellent results: Take alcohol, 1 pint; sandarac, 1 ounce; mastic 1 ounce; common white turpentine, 1 ounce; glue and isinglass, sufficient; water, sufficient. Dissolve the two resins—sandarac and mastic—in the spirit, and and then add the turpentine to the solution. Make some very strong glue, and add to it a good pinch of isinglass. Now heat the alcoholic varnish until the liquid begins to boil, then very slowly stir in the warm glue. The amount of the liquid glue to be added is determined by noting the point at which, after thorough mixture, a magma or thin paste is formed, capable of being easily strained through cloth. When required for use, the strained mixture is to be warmed, and applied like ordinary glue to the articles to be united. A strong junction is effected, which is not destroyed by cold water, and only after a comparatively considerable time by hot water or ordinary saline solutions.

174. Glue, one part; skimmed milk, eight parts. Melt and evaporate in a water-bath to the consistence of strong glue. This cement cannot be called waterproof, but it resists the action of water better than common glue.

175. Melt common glue with as little water as possible,

add 1-8th of boiled linseed oil, dropping it gently into the glue, which is to be stirred all the time.

Wollaston's White Cement.

176. This is a very valuable cement for large objects, such as shells, fossils, etc: Beeswax, 1 oz.; resin, 4 oz.; powdered plaster-of-Paris, 5 oz. Melt together. To use, warm the edges of the specimen and use the cement warm.

Zeiodelite.

177. This cement consists of 19 parts of sulphur, and 42 parts of powdered glass or earthenware, mixed thoroughly together by heating the sulphur. It may be used instead of hydraulic cement for uniting stones or bricks, and for cementing iron rods into holes cut in stone.

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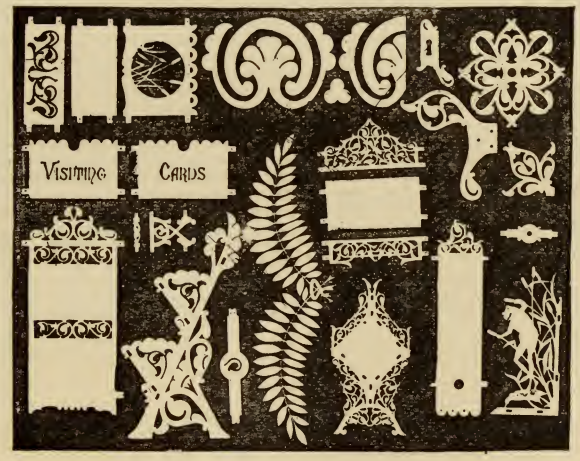

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